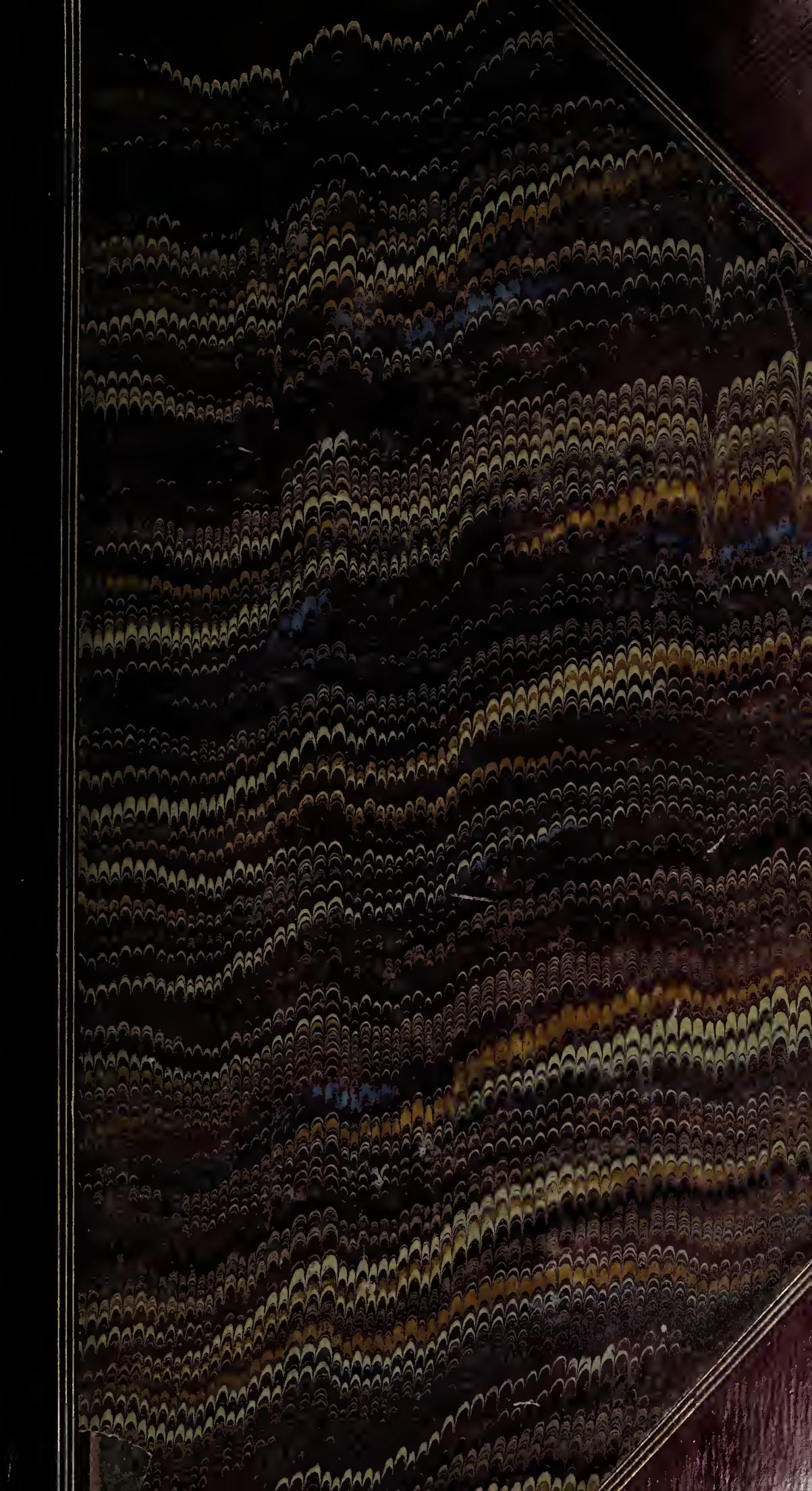

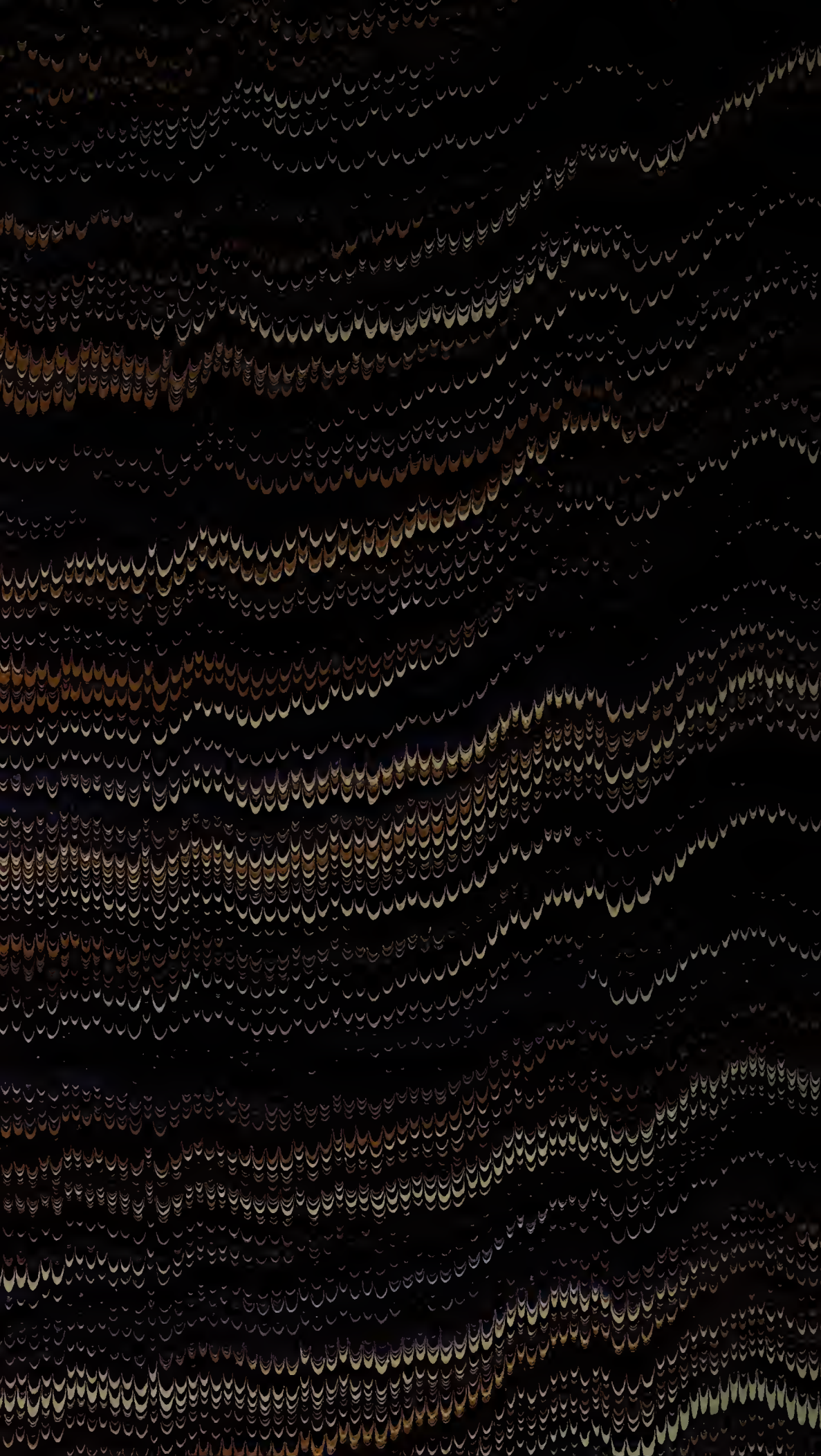

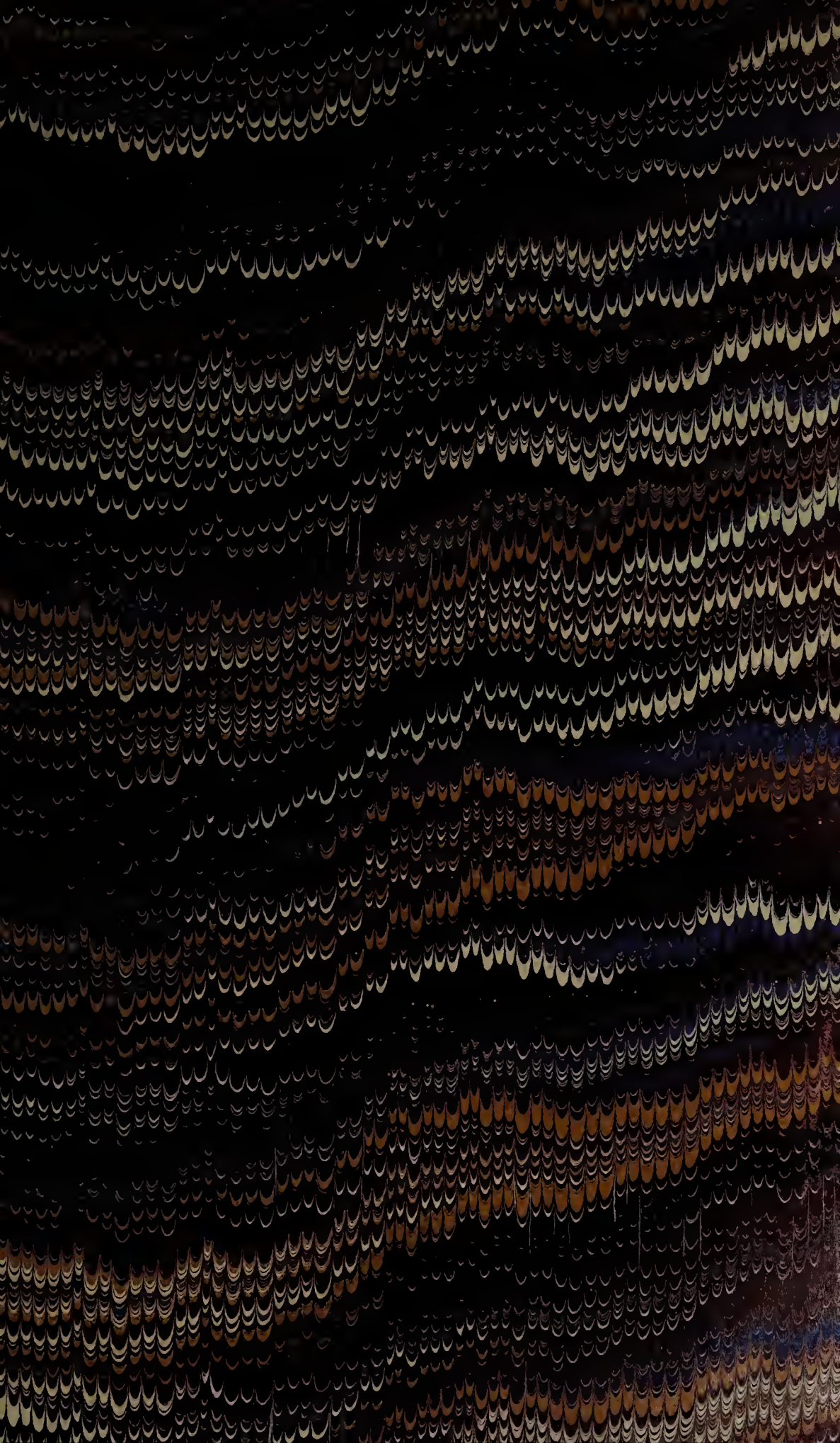

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OF THE

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The Ashmolean Society desire it to be understood, that they are not answerable, as a body, for any facts, reasonings, or opinions, advanced in papers printed by them.

NARRATIVE

OF AN

EXCURSION TO THE LAKE AMSANCTUS

AND TO

MOUNT VULTUR IN APULIA

IN 1834.

BY

CHARLES DAUBENY, M.D. F.R.S.

PROFESSOR OF CHEMISTRY AND BOTANY.

OXFORD,

PRINTED BY S. COLLINGWOOD, PRINTER TO THE UNIVERSITY, FOR

THE ASHMOLEAN SOCIETY.

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NARRATIVE

OF

AN EXCURSION TO THE LAKE AMSANCTUS AND TO MOUNT VULTUR IN APULIA, IN 1834.

READ TO THE ASHMOLEAN SOCIETY, DEC. 4, 1835.

WHEN we consider the rambling propensities of our countrymen, who every year since the peace have peopled at certain seasons the great roads of the continent, creating a new class of inns for their express accommodation, and introducing their own usages and fire-side comforts into the most distant extremities of Europe, it is singular, how few ever deviate from one or two beaten tracks, and what a scanty measure of information is doled out to us, with respect to places, that lie only a short distance apart from those lines, along which the tide of modern travelling is accustomed to flow.

So long as our inquiries, whether they chance to be of a scientific or of a literary description, are limited to a certain established range of country, we are absolutely embarrassed by the multitude of guide-books and travels that recommend themselves to our notice, and find ourselves provided with more minute instructions, as to the objects of curiosity existing in many parts, for instance, of Italy, than we are with respect to those of our own country.

But when we wish to step a little out of the beaten path, and desire to explore those parts of the continent, which, though lying neither in the direct road to Vienna, to Naples, or to Switzerland, are yet not without their own peculiar sources of interest, we often find it difficult to ascertain even the com-

monest particulars, with respect to the inhabitants, their roads, or their accommodations; and regard the most scanty and jejune account, which we may chance to discover, respecting such places, in the light of an important acquisition.

It is with this feeling, that I now offer to the Society a brief sketch of a tour, which I performed last winter through a part of Apulia, which, although abounding, not merely in curious natural phenomena, but likewise in picturesque beauties, such as at a better season would render it highly attractive to every lover of bold and romantic scenery, has scarcely to my knowledge been described in any of the many books of travels that have issued from the British press since the peace of 1815.

Mr. Fuller Craven, indeed, in his Tour through the southern Provinces of the Kingdom of Naples, has noticed a portion of the road; but he has almost entirely omitted mention of the two points which above all others attracted me to that country, I mean the Lago d' Ansanto and the extinct volcano of Mount Vultur; and sir R. Colt Hoare, who published his Classical Tour with the intention of supplying those blanks which existed in the descriptions given of the interior of Italy, was prevented, by the inclemency of the season, from proceeding further on the road to Apulia than Benevento.

In order therefore to render my Narrative of some use to those, who may be induced, though with different views to mine, to visit, the classical country of the Samnites and the Hirpini, the birthplace of Horace, or the field of Cannæ; all objects that might be readily comprehended in a tour similar to

one I accomplished; I shall on the present occasion, not merely state the results of my inquiries into those natural phenomena which lay in my way, but throw the whole into the form of a journal, extracted, with some few additions, from the diary made on the spot [a].

On Wednesday, December 3, 1834, having engaged a Neapolitan Vetturino for the whole of my projected journey, I started from Naples, and proceeded by the Porta Capuana along the great road made in the reign of Charles V. through Apulia, which being the only one existing in the whole country, excepting that to Rome, excited great admiration at the time, and is celebrated by elaborate Latin inscriptions placed upon blocks of stone, that still stand on the road's side, along a considerable part of the line, at intervals of only a few miles.

The first portion of the way lay along a level plain, which in the vicinity of Naples is marshy and unwholesome, from the overflowings of the waters of the Sebeto, once a considerable stream, but now, from the changes effected in the level of the country by the eruptions of Vesuvius, contracted to an insignificant rivulet, which loses itself chiefly in swamps, without reaching the sea. As we proceeded, the country on either side appeared to increase in fertility; and though we were in the midst of winter, yet it was easy to imagine the luxuriance which it must present in autumn, when the elms and poplars, which extend along the whole of this great plain to the very foot of the Appennines, continue in

[a] For the distances, see the post road given in the Appendix.

full verdure, and are united by festoons of vines, stretching from tree to tree, and loaded with a profusion of fruit.

The substratum is made up of a volcanic tuff, such as we see every where in Campania, the wide extent of which plainly indicates, that volcanic action had been rife in the country, long before Vesuvius began to emit lava, and when the country was still under water.

Near the village of Cisterna, a few miles from Naples, I perceived a quarry of leucitic lava, very similar to that of the Monte Somma, and evidently constituting a stream which had descended from that mountain, and not from Vesuvius. Since indeed the focus of eruption has been transferred to the present crater, the whole of the northern skirts of the mountain have been screened from lava-currents by the intervention of the M. Somma, the summit of which constitutes a great semicircular wall, having betwixt it and the crater of Vesuvius, the valley known by the name of the Atrio del Cavallo. The existence of this lava-current would therefore in itself furnish a sufficient proof, were any wanting, that antecedently to the famous eruption in the reign of Titus, to which we are led to attribute the commencement of the eruptions of Vesuvius itself, and the breaking away of the great crater, of which Monte Somma still forms a part, lava-currents had been given off from that part of the volcano, which is now in a quiescent state.

Having nearly reached the foot of the Appennines, we turned off from the direct road to visit Nola, a town of much classical repute, but at present presenting scarcely any remnants of antiquity. Those

who, like myself, are induced to diverge from their route in order to visit it, will do well to inspect a collection of Etruscan vases, belonging to a priest resident in the place, which, though not large, appears extremely choice.

After leaving Nola, we soon began to ascend the Appennines, a mass of limestone for the most part destitute of petrifactions, though generally regarded as coeval with that of the Jura mountains; which latter again appear to have been identified in point of age with the oolitic rocks of England.

This range of mountains stretches like a great wall from the north-west to the south-east, extending from the Alps to the very foot of Italy, but leaving on either side of it a considerable tract of comparatively level ground, of which the Campagna di Roma, the Pontine marshes, and the Terra di Lavoro round Naples on the west, and the flats of Taranto, Bari, and Otranto on the east, may be cited as examples.

That the tuff which we found on the plain should also extend to a considerable distance up the slopes of the Appennines, I was fully prepared to expect from having observed the height which the same stratum attains near Naples, at the Camalduli, and in other places.

But it is interesting to be able to trace proofs, in the relative position of the Appennine limestone and the volcanic tuff, of the elevation of the former rock, and even its excavation into valleys, having taken place, prior to the formation of the volcanic matter which rests upon its flanks. This I infer, from the appearance of the limestone jutting out, and, as it were, protruding itself in several places, at an elevation much inferior to that which the tuff is

seen to attain; and likewise from the occurrence, high up on the chain, of lateral valleys, the summits of which are capped with limestone, though the hollows and sides present only tuff. The sides of the road which we ascended afforded us an excellent section of the materials of which this volcanic deposit is composed. I found it to consist of an alternation of beds, of volcanic tuff, and of pumice of various colours and consistence. The great thickness which the mass must have attained, when it extended over the plain of Campania, as it once appears to have done, to a considerable height above its actual level, and the vast number of strata which might be counted on our ascent, are circumstances which forcibly arrest the attention of the scientific traveller, but which more properly belong to the general history of volcanos, than to the present detail of local phenomena[a]. I may however remark, that this filling up of valleys previously existing in the older rocks of the country, by volcanic tuff, is by no means peculiar to this locality; it is observable at Sorrento on the one side of Naples, and at Caserta on the other; but nowhere perhaps is it so well seen as on the road into Apulia, both from the many miles over which it there extends, and from the section constantly exposed by the great military road which intersects it.

Having reached the summit of the Appennines, we were rewarded by a magnificent view on either side: on that of Naples, the Terra di Lavoro, unrivalled for fertility, lay stretched before us in all its beauty; but still more striking was the prospect on the side of the Appennines.

On a hill to the right is the picturesque ruin of an

[a] See Appendix.

ancient fortress, called Monte Forte, very formidable in the middle ages, and also celebrated, if I was rightly informed, as the spot where the last ill-fated Neapolitan revolution first broke out.

On a much loftier hill to the left, called Monte Vergine, the sides of which are clothed with chestnut trees, formerly was the site of a temple of Cybele; now, without any diminution of its former sanctity, dedicated to the Madonna, to whose honour a monastery has been erected on the summit.

Once a year, thousands from all parts, regardless of the steepness of the ascent, toil up the mountain, either to offer their adorations at the shrine, or under the influence of the various human motives which conspire to swell the numbers collected on such occasions.

Lastly, in front of us was stretched the elevated table land of the province of Principato Ultra, which, although diversified every where by valleys and acclivities, is throughout raised considerably above the level of the great plain of Campania.

Accordingly our descent was much less considerable than our previous ascent had been; and after reaching the little village which lies under the old fortress of Monte Forte, an avenue of poplars, nearly a mile in length, brought us to the town of Avellino.

Avellino itself is a large and populous place, the capital of the province, and the residence of the governor or intendant. It is now, as of old, famous for its orchards and its hazel-nuts. Virgil celebrates the former,

Et quos maliferæ despectant mœnia Abellæ;

and the name of nux Abellina given to the hazel-nut indicates the abundance of that tree in its

neighbourhood. To the stranger, however, it presents few objects of interest; and all I need remark further respecting it is, that the traveller will meet there with a very tolerable inn, and that he will find it convenient to make it his starting-place for the Lake Amsanctus, which may be reached from it on horseback in little more than half a day, thus allowing time, in the fine season, to proceed onwards before night-fall to Ariano, where decent accommodations may likewise be secured.

Being encumbered with a carriage, I was compelled to take a more circuitous route, which traversed an upland, and, for the first part of the way, an highly picturesque country, passing through Pratola and Mirabella, where I diverged from the main road, in order to reach the little town of Frigento, situated about five miles to the east of it.

For some miles after leaving Avellino, I was surprised at observing a continuation of the same strata of volcanic tuff which I had traced all the way during my ascent; so that, as it is quite evident that no volcano exists in the neighbourhood, from which they could be derived, we can only suppose that the waters which washed this material into the Appennine valleys, as before noticed, extended to such a height as to spread it over the crest of the mountain chain which we crossed on reaching Avellino. All traces of volcanic matter appeared however to have ceased several miles before we turned off from the main road at Mirabella, and nothing appeared but the blue compact limestone of the Appennines, alternating with beds of grit, but uncovered by any other material.

Frigento itself, like most of the towns in Apulia,

is built on the brow of a hill, and is inaccessible for carriages: leaving ours, however, at an osteria below, we ascended it on foot, and found there an hospitable reception in the house of Don Martino, one of the principal proprietors of the place, who had been prepared for our visit by a letter from a relation at Naples, and was looking out for our arrival.

Nothing, I am sure, could exceed the hospitality and kindness we experienced during our stay from this gentleman and his brother the Canonico; but for the sake of those who may follow a similar route, I will remark, that in this bleak and exposed country, December is not the month to enjoy comfort in the country houses of the Neapolitan gentry. In all parts of the world the habits and fashions of the capital are more or less a law to the provinces; and as the Londoner has introduced at Naples the grates and coal fires which he uses at home, so in the little town of Frigento, the very name of which (Frigento, a frigore) indicates its bleakness, the casino of my friend Don Martino was built after the fashion of those in the plain of Campania, and boasted not a single fire-place in any one apartment excepting the kitchen.

There accordingly the whole family (for they were by no means Stoics as to cold) crowded after their evening repast was concluded, and being joined by a number of their neighbours, who had been attracted by the uncommon sight of an English traveller, formed a considerable circle round the hearth.

When we retired from this room, a brazier was the only mode of obtaining warmth that remained for us; and it is one which, except in such severe weather, we should hardly have wished to resort to,

from the oppressive and unwholesome fumes which attend its use.

The next morning I proceeded to the lake or pool of Amsanctus, which is situated in the plain below, about midway between Frigento and another similarly situated town called Grotta Maina [b].

The lake and valley of Amsanctus is familiar to every schoolboy, as the spot through which Virgil represents the fury Alecto, after having excited discord between Turnus and Eneas, as descending to the infernal regions.

Some indeed have suggested, that Virgil alluded to certain sulphureous ponds that occur near Rieti, above the famous falls of Terni, where the immense accumulation of travertine proves, that the extrication of carbonic acid, and probably of other gases usually accompanying it, has been taking place on an enormous scale; but the locality seems to be fixed by a passage in Cicero, who expressly says, that the Lake Amsanctus lies in the country of the Hirpini, "Quid enim? non videmus quam sint varia terrarum genera? Ex quibus, et mortifera quædam pars est, ut et Amsancti in Hirpinis, et in Asia Plutonia." A passage in Pliny might also be quoted to the same purpose, but the description which Virgil gives is so applicable to the spot, that I conceive no doubt can remain as to its identification. Thus Ansanto stands "Italiæ medio," (midway between the Adriatic and Mediterranean,) "sub montibus altis," (having in its immediate neighbourhood the hills of Frigento, Villa Maina, &c., and at a still greater distance, the mountainous heights of Monte

[b] Mr. Hamilton has published in the third volume of the Geographical Journal an account of his visit to this spot.

Vergine, and other of the loftiest points in the chain.) It stands in a little valley, which till lately was flanked on either side by a thick wood,

densis hunc frondibus atrum,
Urget utrinque latus nemoris,

for it was only in the time of Murat that the wood on the right hand was cut down; whilst a small mountain torrent flows down the valley, and supplies the lake,

medioque fragosus
Dat sonitum saxis, et torto vortice torrens.

Here from the pool, which occupies a particular spot where the valley is somewhat wider than elsewhere, issues an enormous quantity of noxious gas, whilst the same proceeds copiously from a cavity in an adjacent rock, so that the latter part of the poet's description is exactly verified,

Hic specus horrendum, sævi spiracula Ditis,
Monstratur; ruptoque ingens Acheronte vorago
Pestiferas aperit fauces.

Lastly, they point out on an adjoining eminence some vestiges of the neighbouring temple to the goddess Mephitis; and Romanelli notices an inscription found on the road from Ariano to Montecalvo, which makes mention of a votive offering presented to the goddess by a Roman lady,

Paccia Quintilla Mefiti votum solvit.

In our visit to this place, after we had descended the hill on which Frigento stands, we shortly came upon a small pool of water which, like the larger one to which attention has chiefly been directed, emits a quantity of gas. This I collected in the usual manner, by inverting a jar full of water over the spot, on the surface of the pool, from which

the bubbles issued; and on my return to Frigento in the evening, submitted it to chemical examination, and found it to consist partly of carbonic acid, and partly of sulphuretted hydrogen. After the removal of these two gases, however, there was a small residuary quantity of air, which contained about 16 per cent. of oxygen and 84 of nitrogen.

We next reached the narrow valley, or rather watercourse, in which the larger pool of Amsanctus is situated. Nearly two miles below it is a warm spring, which disengages carbonic acid and sulphuretted hydrogen gases, and which in the lapse of ages has produced on either side of the water a thick deposit of travertine.

A little beyond us, towards the south, was the town of Villa Maina, standing on an eminence, which I am induced to notice from a circumstance, stated to me by a resident gentleman, who was of the party, respecting it, which seems worthy of notice.

He assured me, that the health of the inhabitants had appeared to suffer materially, since the cutting down of the wood which lay betwixt them and the mephitic lake; that they were sensible of the odour proceeding from it when the wind blew from that quarter, which was not the case before; and that they attributed the insalubrity of the situation to that circumstance. My informant further assured me, that the inhabitants of Villa Maina are noted for the sallowness of their complexions, and that the disease to which they are chiefly subject is an affection of the liver.

Fanciful as it may appear to connect any disorder of the animal functions with the minute quantity of a deleterious gas, which can be so wafted to a dis-

tance, so great as four miles from the place of its emission, I am not disposed altogether to pronounce it impossible; for without being a convert to the doctrine of homœopathy in the extent to which it is carried, I can conceive, that the long continued action of a very minute quantity of a noxious ingredient may sensibly influence the system, whilst an infinitely larger dose, applied during a short space of time, may be thrown off without inconvenience, in consequence of the resistance which the vital principle opposes to its introduction, or, as our predecessors in the medical art preferred to denominate it, the *vis medicatrix naturæ*. Thus it is at least not absurd to suppose, that an individual who had exposed himself for some hours to these vapours within the crater of Vesuvius, in the most concentrated state in which they can be endured without subsequent injury, might be affected by inhaling, during many years, a very minute portion of the same, wafted from the Lake Amsanctus, whenever the winds set in that direction.

The quantity of mephitic vapour which proceeded from that quarter was such, as to oblige us (the wind being in the north) to take a circuit towards the east, in order not to meet the noxious blast; instances not unfrequently occurring of animals, and even men, who have imprudently ascended the ravine, being suffocated by a sudden gust of air wafted from the lake.

This is the origin of the fable of the Vado Mortale, a particular spot in the course of the rivulet that flows from the lake, which, it is said, cannot be forded without death, and which has been described, as having on its borders an accumulation of the whitened bones of the various animals that had

perished there, which must for ever lie on the spot where they fell, because no living creature can approach to take them away without adding to their number.

The wonders of the Lake Amsanctus are sufficiently striking without such exaggeration; no bones existed in the valley at the time I visited it, excepting of some birds, who, in crossing the valley, had been arrested on the wing by the noxious effluvia, as at the Lake Avernus of old; neither even close to the lake, where the evolution of gas is most abundant, is there any point at all times unapproachable, for we ourselves were able to reach its edge on the side from whence the wind blew.

I have already stated, that the pool itself stands in a part of the ravine, which is widened out considerably, contracting again to its original dimensions below. It has been stated as being about 20 paces in its smallest diameter, and 30 in its largest, which I conceive to be near the truth; and its depth is said to vary from 6 to 7 feet. From the quantity of gas which is continually escaping, it appears to be throughout in a state of violent ebullition, but its temperature little, if at all, exceeded that of the surrounding atmosphere.

The colour of the water is dark and muddy, from the quantity of sediment projected towards the surface, owing to the constant agitation into which the pool is thrown by the gas that rises up through it; its taste strongly bespeaks the presence of alum, which is said to render it efficacious in the cure of certain diseases of cattle.

One of the guides, who approached its edge, filled a bottle with the water; but to have collected the gas itself, would have been a perilous attempt.

I can only infer therefore, that it resembles that which issued in smaller quantity from a more inconsiderable pool within a hundred yards of the spot, and which consisted mainly of carbonic acid gas. The smell, however, plainly indicated that sulphuretted hydrogen was likewise emitted at the former vent; and the consequences of the long-continued action of this gas upon the constituents of the contiguous rock, was not one of the least interesting or instructive parts of the phenomena presented in this locality.

The rock itself, every where in the vicinity of the Lago d' Ansanto, is the common blue fissile limestone, interstratified with beds of grit, which had accompanied us from Avellino. There is nothing that reminds us of volcanic action, except about the lake, where those products, which usually are found in solfataras, and in other spots exposed to the action of sulphureous vapours, abound.

Thus the rock immediately round the pool consists of a pulverulent earthy substance, derived from the conversion of the carbonate into sulphate of lime, and the production of alum from the union of the same acid with alumina; sulphur, derived from the sulphuretted hydrogen gas, also impregnates it in sufficient quantity to be worth collecting; and in some places the colour and smell indicate the presence of petroleum, disengaged along with the sulphur from the depths below.

Moreover, as a proof that this action is not altogether local, and that it is capable of producing effects on a scale commensurate to those exhibited in several of our rock formations, we observe at a short distance, resting upon the Appennine lime-

stone, a bed of gypsum nowise different from those occurring in many tertiary deposits.

Now it was interesting to me to remark the analogy between the appearances presented here, and those at the Lagoni near Volterra in Tuscany, which I had visited on my way to Naples just before. There, too, volcanic rocks are entirely absent; and the formation for many miles round the spot consists of the Appennine limestone, with serpentine or diallage rock protruding through it.

But at the Lagoni we see pools of water in a state of absolute ebullition, from the quantity of steam which is constantly rising through them, and which imparts to them a temperature exceeding 180° of Fahrenheit. This steam seems to carry up with it boracic acid and sal ammoniac; the former in sufficient quantities to make it worth while to evaporate the water through which it passes in order to collect it; the liquid being conducted into shallow troughs, where it is mixed with soda, by which addition crystals of borax are obtained from it as the aqueous portion escapes.

Now when we compare together the effects produced by the disengagement of steam and sulphuretted hydrogen, owing almost unquestionably to a volcanic cause, in the instance before us and in that of the Lake Amsanctus, we are naturally led to apply the same explanation to those immense deposits of sulphur which occur on the western side of Sicily. If any doubt should exist as to the fact of their having been so produced, it may be removed by reflecting, that we know of no instance of sulphur being sublimed in an uncombined form by volcanic action, and that it seems scarcely possible for such

an event to occur, without the combustion of the sulphur taking place the instant of its coming into contact with atmospheric air.

Hence it may be inferred, that the whole of this vast deposit in Sicily has been occasioned by a decomposition of sulphuretted hydrogen gas, such as has taken place on a smaller scale at Lake Amsanctus, and has there impregnated the surrounding rocks with crystals of the same material.

In Sicily too we meet with all the combinations which sulphuric acid is capable of forming with the earths present—in the beds of sulphate of lime, of strontian, of barytes, of magnesia, that occur—there also we see in the immediate neighbourhood warm springs impregnated with sulphuretted hydrogen—memorials, as it were, of the cause, which had produced these deposits.

May we not also be led to conjecture, that the gypsum so commonly present in the tertiary clay of Volterra and the maremnæ of Tuscany, has been produced by the same process, especially when we find this clay associated, as it frequently is, with beds or nests of sulphur.

Thus the formation of the blue clay, in Sicily and in the maremnæ of Tuscany, would have taken place, not only at the same epoch, which is generally admitted to have been the case, but under the same physical conditions, one as the other, and a volcanic action similar to that going on at the Lago d' Ansanto and at Monte Cerboli would likewise have given rise to the deposits, which the former contain, in common with the rocks found immediately round the spots, where the above operations are at present proceeding.

But there is another circumstance also worth no-

ticing, although the inference to which it seems to point will scarcely receive admission until further proof can be adduced in support of it. I allude to the association of salt springs with gypsum and sulphur both in Tuscany and Sicily. Their occurrence in such localities as these might induce us to conjecture, that the same volcanic action, which produced the sulphuric salts, and volatilized the sulphur, has been instrumental also in separating the salt from its solution in water, and thus serve to explain, in these instances at least, the puzzling fact, that rock-salt is found associated, as is so commonly the case, with beds of gypsum. The connexion between the above phenomena may perhaps be seen more clearly by the following tabular view:

Volcanos give out.....	sulphuretted hydrogen, sal ammoniac, boracic acid, muriatic acid, steam;
and cause	deposits of sulphur, of sulphuric salts, of muriatic salts, &c.
Moffettes, connected geographically with volcanos either now in action, or extinct, give out	the same principles,
and cause.....	deposits of sulphur and of sulphuric salts.
Many tertiary clays, some of which are connected geographically with volcanos, contain.....	beds of sulphur, of earthy sulphates, and of common salt.
Most salt formations are associated with.....	beds of gypsum,
some with.....	sulphur,
others with.....	sal ammoniac.

To return from this digression to the Lake Amsanctus.

It is interesting to remark, that the position of this spot is almost exactly intermediate between the active volcano of Vesuvius and the extinct one of Mount Vultur, and that a straight line drawn from the one to the other, and which might likewise be extended on to the volcanic island of Ischia, would pass within a mile or two of this mephitic lake.

From the neighbouring eminence on which Frigento is situated, the summits of both mountains were alike visible; and it was stated to me on the spot, that when Vesuvius was in a state of activity, an unusual quantity of gas was disengaged from Amsanctus. Hence it seems probable, that the same elements of volcanic activity exist underneath the earth all across the peninsula, although these elements may be called into more intense action on either side of the Appennine chain, by the proximity of sea water, or by some other circumstances which do not occur in the central portion of the chain.

The occurrence of Plutonia, or places which disengage large volumes of noxious gas, is familiar in all volcanic countries, but I know of no other instance, in which the quantity is considerable enough to endanger life in the open air round about the point of its emission, except that of the Valley of Death in Java [a].

[a] It is a valley near the summit of a mountain, about half a mile in circumference, the depth from 30 to 35 feet, the bottom quite flat, no vegetation, a few large (in appearance) river stones, and the whole covered with the skeletons of human beings, tigers, pigs, deer, peacocks, and a great variety of birds and beasts. The party who visited it could not perceive any vapour or

The accounts given of the dangers of this valley, combined, by an extraordinary confusion of ideas, with those respecting the Upas tree of the same island, which was said, like the Manchineel of the West Indies, to be noxious to those who slept under it, gave birth to the monstrous eastern fable concerning the tree reported by Darwin;—of its tainting the air around for several miles by its pestilential effluvia; of its converting the whole neighbouring country into a desert by its malignant influence upon vegetable, as well as animal life; and of its yielding a poison, so subtle as to destroy life by a single drop, and so dangerous to those who collected it, that the malefactors who undertook that service for the emperor, received a free pardon, if they returned alive [a].

These two localities possess an interest independent of the romance which attaches to their history, as shewing that causes are in operation at the present day in spots remote from ordinary volcanic phenomena, on such a scale, as would in a comparatively short period modify the character of the earth's surface over a considerable surface, and produce new deposits bearing a comparison in kind and in extent to those which geological observation presents to us.

The following morning I left the hospitable roof

opening in the ground, which appeared to be of a hard sandy substance. The sides of the valley, from the top to the bottom, were covered with vegetation, trees, shrubs, &c. They descended within 18 feet of the bottom, below which the air was too noxious. Dogs and fowls sent in to a lower point died in a few seconds. The human skeletons are supposed to have been rebels, who had been pursued from the main road, and had taken refuge in these dangerous valleys. There is no smell of sulphur, though the whole range of hills bordering on the spot is volcanic.

of signor Martino, and regaining the great road at Mirabella, proceeded onwards towards Mount Vultur. The first town we reached on our road was Ariano [b], situated on the summit of an eminence, composed, not of the Appennine limestone which we had hitherto met with, but of alternations of loose sand-stone and marl, resting upon a conglomerate full of pebbles, chiefly composed of this older calcareous rock. The sand-stone abounded in shells, but they were extremely fragile; murex, turbo, buccinum, venericardia, ostrea, and anomia, were the most common genera.

In order to explain the occurrence of these tertiary marine deposits at such a height on the centre of the Appennines, I cannot do better than quote the words of Brocchi [c].

"At one period the habitable part of Italy was reduced to the ridge of the Appennines, which formed a long and narrow peninsula connected with one of the heights of the Alps. Though we must not suppose this tract to have been quite continuous, yet I believe that it extended over a great space without a break, since the valleys which intersect the Appennines, supposing that such as now exist were there at the time, are neither very numerous, nor sufficiently deep, to have connected the two seas

[b] Supposed by some to be the Equus Tuticus, referred to by Horace, as the "oppidulum quod versu dicere non est." Its situation on the top of a hill might account for the scanty supply and dearness of water:

"venit vilissima rerum
Hic aqua."

But Dr. Cramer places the old town alluded to five miles further north, where the church of St. Eleuterio now stands.

[c] Concholog. subappenn. page 58.

together, and to have converted the ridge of the Appennines into a succession of islands. In fact the principal passes which traverse this chain of mountains, are carried over eminences of considerable height, such as that of Abetoni between Pistoya and Modena, which has an elevation, according to Pini, of 4166 feet; that of Pietramala between Florence and Bologna, Furlo near Fossombrone, Colle Fiorito between Terni and Foligno, Bocchetta in Liguria. In order to determine with precision the length of this ancient peninsula, and to mark the spots where its continuity was broken, we ought to ascertain what was in different places the elevation and depression of the central portion of the Appennines, previously to the corrosions and rents which the rivers and torrents had in after-times effected. One of these interruptions certainly existed in that part of the kingdom of Naples, which bears the name of the Principato Ultra, and was in a valley which is prolonged from Avellino to Bovino, and which leads from the Terra di Lavoro into Apulia. This valley at one time cut through those Appennines to which belong the gigantic calcareous mountains of Incoronata, Monte Vergine, and Avella, for if on the side of Ariano, or in its central portion, it is seen to be closed in by great eminences, the latter have been formed by deposits analogous to those of the hills of Tuscany and the Romagna, consisting in a calcareous sand with grains of silex and scales of mica, which at Monte Reale, between Bovino and Ariano, as likewise between this latter place and Grotta Minarda, is seen to be superimposed on a marly bluish clay. This sand extends from the side of Apulia nearly to Ordona, and is pro-

longed beyond Naples, though near Pratola it begins to be covered with a volcanic tuff derived from the substances erupted from the submarine volcanos of Campania, or transported by the waters which insinuated themselves into the hollows and recesses of the surrounding mountains.

" The valley of Bovino then separated from the rest that tract of country comprehended under the Basilicata, Apulia, and Calabria, which then appeared like a distinct island, or rather was an union of islands formed by the highest peaks of these mountains, since the Murgiæ of Apulia, and the low eminences, which, branching through the territory of Otranto, extend as far as Cape Leuca, then continued submerged."

On this description of Brocchi's I would only observe, that the whole of the valley spoken of must not be inferred to be covered with tertiary deposits: on the contrary, the line of road I pursued from Avellino to Frigento, and from Frigento to Ariano, presented only the Appennine limestone with its subordinate beds, until we came within a few miles of the latter town, which stands on a lofty eminence, composed entirely of tertiary beds, resting on a loose conglomerate.

The softness of the stone of which the rock consists has rendered it so easy to hollow out, that the whole surface towards the south is honeycombed into caves, which form the dwelling-places of a large proportion of the population, as is the case in one or two places in the tertiary deposits of central France, at Lisle, &c. It is remarkable that the people, and more especially the children, who emerged from these damp and sombre habitations, seemed

perfectly healthy, contrary to what has been observed in some other places of the kind, where, in consequence, as is supposed, of the absence of light, the form and functions of the animal system are but imperfectly developed [c].

From Ariano we proceeded along the valley till about nightfall, when we reached the bridge of Bovino, the town itself standing on an eminence above.

This spot, I may remark, was formerly infamous for the robberies committed in it; the locality being peculiarly favourable for such enterprises. For the last few miles the road lay in a narrow glen, hemmed in on either side by a steep ridge, covered on the top with wood, from whence the robber could watch his prey, and plan his attack at leisure. Add to which, that there were no means of escape, except through the pass at which the bridge of Bovino stands, and that for several miles before reaching it, there is no track to the right or left branching out of the main road, by which the traveller might avoid the danger awaiting him.

Even now, that the bands which formerly infested the country are destroyed, videttes continue to be planted at distances of a mile or two along the whole of the pass, and few choose to delay their journey through it till the close of day.

Finding only a most filthy inn at the bridge of Bovino, and not relishing the idea of being benighted in such a country, we were fain to put up at an *osteria* a few miles beyond, where we should have

[c] See Dr. Edwards' experiments on tadpoles, which, when secluded from light, never underwent their metamorphosis into frogs, though they continued to increase in size.

fared but badly, had we not brought with us our own provisions, and been able to avail ourselves of our carriage as a retreat for the night.

At the bridge of Bovino we took our leave of the Appennine chain, and found that we had begun to enter upon the wide plain, which extends to the shores of the Adriatic, a distance of nearly thirty miles. This tract seems to be wholly composed of very recent deposits, and to have constituted at a comparatively modern epoch, a gulf of the sea, which was at that period circumscribed, on the south-west by the range of hills which stretches from Bovino to the neighbourhood of Melfi, and is from thence prolonged to the present gulf of Taranto, and on the north by the heights of Mount Gargarus in Manfredonia; both equally belonging to the Appennine chain, and consisting of older formations.

At that point, we quitted the great road into Apulia, which had brought us thus far with ease and safety, and had to plough our way as best we could, through a wild uninclosed tract of land, chiefly devoted to pasturage, but, so far as relates to roads, and other evidences of human cultivation, in a condition little more advanced than when it first emerged from the ocean.

To those who are disposed to follow my footsteps, I may suggest, that this part of the journey would be accomplished far more expeditiously, as well as more agreeably, on horseback, in which case the traveller might, if well-mounted, reach Melfi, the nearest town to Mount Vultur, in one day from Bovino, by setting out at an early hour.

Encumbered by a carriage, and travelling at a season, when the sandy loam over which we had to

pass, was rendered stiff and heavy by the rains that had fallen, we could get no further that day than Ascoli, a wretched town, where we procured very sorry lodgings at a little inn kept by an old woman, possessing a strongly marked physiognomy, but whose haggard looks and wild expression of countenance might have suited one of the witches in Macbeth. Being curious to learn her history, I made inquiries of a person of the town with whom I chanced to converse, and was told, that she was the sister of one of the famous robber-chiefs of Apulia, and in her youth had possessed considerable personal charms; that she had lived with her brother and his troop during many years in their mountain fastnesses, and had shared their prosperous days; but when the band was broken up, and her brother had been apprehended and executed, had found it necessary to take up with the occupation of an innkeeper, which in my informant's opinion was a great sinking of caste. His feeling on this last point will seem more intelligible, when we recollect, that at a time not very remote, the leaders of the banditti in Apulia were generally persons of some rank; that they often combined a wild feeling of chivalrous honour with their lawless habits of life; and that whilst their power made them objects of terror to all, their system of confining their outrages to the rich, created a kind of fellow-feeling in their behalf amongst the humbler classes.

Ascoli, the ancient Asculum, is celebrated for the second battle between Pyrrhus and the Romans, which, though hotly contested, terminated without any signal advantage on either side. It stands on a hill, based on a shining, glary, sandy clay, upon which rest beds of yellow sand; the whole being

capped with thick beds of conglomerate, in which rolled pebbles of the Appennine limestone, and of some other rocks, none of which however are volcanic, are firmly agglutinated together by sandstone, so as in some places to constitute a very coherent mass. I could perceive no organic remains in any part, but have no doubt, from its general aspect, that it is of tertiary origin.

The next morning we prosecuted our route to Melfi, passing at first over a plain as wild and as uncultivated as that we had traversed on the day preceding. About nine miles from Ascoli we crossed the Ofanto, the Aufidus of the ancients, a river at the time we passed it of very inconsiderable size. We had next to ascend several pretty lofty ranges of hills, from the summit of the last of which the town of Melfi was visible.

From this point the view that opened upon us was singular and beautiful; at the extremity of the landscape stood the Mount Vultur, which in its general outline bears a striking resemblance to Vesuvius, as we imagine it must have been before it broke out in A. D. 79.

Between the spot where we were and the mountain, stood the town of Melfi, built upon an isolated neck of land, with its castle, a picturesque building, overhanging the precipice. A little stream winds round the valley, dividing us from the rock on which Melfi is situated, and a bridge thrown over the stream at the bottom of the valley connects the town with the road. No volcanic appearances presented themselves until we reached the range of hills nearest to the former, previously to which, the tertiary sand and clay of the neighbourhood of Ascoli, covered

with puddingstone, containing pebbles of the Appennine limestone, alone made its appearance.

But the range immediately south of Melfi seemed to be based upon the older Appennine limestone, covered over however by beds of tertiary sandstone capped by volcanic tuff, so that, as we descended the valley intervening between this eminence and the town of Melfi, we soon found ourselves travelling upon that limestone.

The hill, however, upon which the town itself is built, consists of different materials. It is based upon beds of volcanic tuff, which (as may be seen in the annexed drawing) dip from the Mount Vultur, so that at the north western side of the rock of Melfi they lose themselves under the surface. These are covered by a thick bed of lava, which presents a precipitous escarpment, as well as an imperfect columnar structure, towards the north-west, and appears to have proceeded from Mount Vultur, though the changes which the country has since undergone may have severed the connexion with its parent.

At Melfi I found tolerably comfortable accommodations at the Nobile Locanda di Sole, and every possible attention from the gentlemen resident there to whom I had brought letters.

The town appears not to have existed in the times of the Romans, but to have been a place of some repute in the middle ages, when the Normans, under Count Ranulph, seized and fortified it. The investiture of the Dukes of Apulia accordingly took place there, and it was at that time considered one of the principal cities of the province.

It is at present a large but an extremely dirty town, principally belonging to the prince of Doria.

It lies so much out of the general route, that the intercourse with foreigners is very small; and the people, though honest and obliging, are ignorant and superstitious to a degree which the stranger will do well to be aware of.

Almost the last scientific traveller before myself, who made Mount Vultur the object of his researches, was the celebrated Italian geologist, Brocchi, who, burdened, not only with a hammer, but likewise with a barometer and other philosophical instruments, proceeded some fifteen years ago to ascend the mountain.

The peasants, at a loss to conjecture the nature of his objects and his manipulations, set him down as a magician, but not knowing whether he might have come to do them good or harm, contented themselves at first with watching him, very attentively, but at a respectful distance. Unfortunately, in the very midst of his observations, the heavens lowered, the wind betokened an impending tempest, and drops of rain began to descend.

The peasants regarded all this as the first-fruits of his incantations, and awaited with silent dismay the result; but when they saw a furious thunder-storm invading their crops, and demolishing their hopes of a coming vintage; whilst the philosopher continued inspecting with redoubled attention those instruments of his craft, which had been regarded by them before with so much suspicion, fear gave way to indignation, and they rushed forwards in a body with the full intent of demolishing the mysterious author of all this mischief.

Fortunately for Brocchi, he had with him three or four resolute gens d'armes, as his escort; and these,

with their muskets and bayonets, contrived to keep the unarmed peasants at bay long enough to enable him to escape, or his zeal in exploring the secrets of volcanic action might have been as fatal to him, as it was of old to Empedocles[f].

The following morning I ascended mount Vultur in company with a gentleman of Melfi, who insisted on being of the party, and two gens d'armes who were sent as an escort, in addition to the ordinary guides, &c. We first wound round the western flank of the mountain, keeping on our right hand the valley, at the bottom of which flows the river Ofanto. Wherever the substratum was exposed, it seemed to consist of volcanic tuff, of which various beds were visible, some very compact, others loose and friable, consisting chiefly of pumice like those about Pompeii [g].

In this loose material we saw several caverns excavated by art, some of which, we were told, had been the lurking-places of those bands of robbers, who within the last twenty years laid the country

[f] According to a recent tourist in Ireland, a similar adventure lately befell a botanist herborizing in the mountains of Connemara during the time the cholera was raging.

He was nearly murdered by the country people, in consequence of being mistaken for a French doctor sent by government to inoculate the people with this dreaded plague; and the tin box, in which he carried his plants, was regarded by them as the case, in which his stock of infection was kept, in readiness to disseminate wherever he went. See Angler in Ireland, vol. i. p. 189.

[g] The neighbourhood is said to yield a profusion of plants, and being almost unexplored by modern botanists, is likely, if visited at the proper season, to yield a rich harvest to the collector. Like most volcanic soils, it produces excellent wine.

under contribution, and made mount Vultur their principal retreat.

After skirting the base of the mountain in this manner, we came at length to the wood, on its southern flank, termed Montecchio, and, having crossed a deep ravine, in which flows a ferruginous water, tinging the stones over which it passes with a red ochreous sediment, entered an extensive forest, well calculated to be the haunt of the numerous banditti who formerly resorted there.

In the midst of this forest is a spring called the Aqua Santa, quite cold, and without any particular taste, but possessing some reputation in the cure of diverse disorders, and giving out bubbles of air. This I collected, and ascertained to consist of carbonic acid gas, together with a small portion of residuary air, amounting to about 1 p^{r}. c^{t}., 100 parts of which contained 10 of oxygen, and 90 of nitrogen [h]. The same gas escapes in still larger quantities from a fissure in the rock hard by, and a considerable deposit of travertine in the neighbourhood indicates, that it has been given off elsewhere [i].

From this point we began to ascend in a northerly direction, and upon reaching a particular point about half way up the mountain, found ourselves in the midst of an amphitheatre of hills, which from its form, as well as the physical constitution of the

[h] Thus confirming the inference which I have deduced from many former observations, that whenever atmospheric air escapes from a volcanic source, it is found deprived of a portion of its oxygen.

[i] The same gas is emitted at a place called Rendina, to the east of mount Vultur, and likewise, together with sulphuretted hydrogen, from some mineral waters near Atella, on the western side of the mountain.

rocks surrounding it, immediately suggested to us the idea of its having been at one time the crater of the volcano. The cavity was nearly circular, and the brim, with the exception of the side by which we had ascended, was almost entire.

Its interior was covered with a rich black soil, having but few blocks of volcanic matter scattered over its surface. The rocks encircling it are very irregular in point of height, some of them rising more than 1000 feet above the average level of the margin. One of these eminences, which partakes of a conical form, constitutes the summit of the mountain; for, as is the case in some other instances, there is no crater on the highest point.

Within this great circular expansion, are two minor depressions, which are likewise nearly round, and, as they occupy the lowest portions of the crater, receive the drainings from other parts. Hence they form two lakes communicating by a narrow outlet one with the other, and discharge their superfluous waters by a little rivulet which runs from the lower or more southern. The water of the latter is perfectly sweet, that of the most northern one is stated to be salt, but it must be slightly so, since fish abound in it.

It is said, that at times volumes of sulphuretted hydrogen, or some other inflammable gas, are given off from this lower lake; and jets of water have been known to be suddenly thrown to the height of fifteen feet above its surface. These circumstances evince, that the volcanic action is not completely spent, and still shews itself at intervals, in an energetic manner, by the evolution of gas. On the borders of the upper lake are the ruins of a church, dedicated to S. Hippolito, and on an emi-

nence overhanging it is a convent of Franciscans, who, protected by the sacredness of their calling, and their supposed poverty, continued to reside without molestation in this sequestered spot, at a time when the mountain itself was the head quarters of the bands of robbers which infested the province. Once a year Melfi pours forth its whole population on a pilgrimage to this sacred spot—prompted by the double motive of paying their adorations at the shrine, and of commemorating the escape which a portion of the inhabitants experienced in 1528, by secreting themselves within the crater, and thus eluding the fury of the French troops under Lautrec, who took the town by assault, and put all that remained in it to the sword [k].

The rocks, which encircle this crater, seem generally to consist of tuff, but the substratum is so completely covered with vegetable soil, that it is difficult to determine its stratification. One side of it is covered with a thick forest inhabited by wild boar, the rest is cultivated, and yields abundant crops.

A heavy shower of sleet obliged me, to abandon my original design of ascending to the summit of the mountain, and to hasten homewards.

We accordingly climbed the western edge of the crater at its lowest point, and having reached the summit, descended the opposite side in the direction of Melfi. Not a single stream of lava was observable on the flanks of the mountain on this side; if any such there be, they were concealed by a thick bed of black unctuous soil, resulting from the mixture

[k] Such was the account given me on the spot, but I confess I do not find it confirmed by the narrative of the taking of Melfi furnished by Guicciardini, or by Sismondi.

of volcanic ashes with the clay which proceeded from the decomposition of harder materials. The extent to which this has taken place,—the rare occurrence, in a mountain which once was the theatre of such extensive volcanic operations, of loose blocks, —and the entire disappearance of streams of lava, would alone imply the great interval of time that had elapsed since their occurrence; but another proof of the same was afforded in the existence of a deep and wide valley, which we crossed on our way, extending from the bottom of the mountain nearly up to the crater, completely covered by vegetation, and with its superficial strata reduced altogether to the condition of a rich and slippery loam.

In the few specimens of volcanic rock met with on our road, either in detached blocks, or composing beds of loose materials, which the soil had not completely concealed from our view, there was a general uniformity of character.

They consisted of a dark, and generally compact, though sometimes cellular, stone, which was made up of an intimate union of minute crystals of augite imbedded in a felspathic base. There were also dispersed through the matrix crystals of a dark green colour, which, from a comparison with others subsequently found, I conclude to be hauyne.

These masses may either have been detached from a stream of lava which formerly had been thrown out, or may have been ejected separately.

If the former were the case, what an idea of antiquity does the complete concealment by vegetation of these streams convey to the mind, when we recollect the ages required to cover over even with lichen those of Etna or Vesuvius!

Yet the whole of these eruptions were posterior to the formation of the tuff constituting the base of the mountain, which is of various degrees of compactness, but for the most part resembles that of Posilippo, containing comminuted masses of pumice imbedded, alternating with beds of loose pumice, without any cementing material.

The rock on which Melfi stands consists of the same substances, but hauyne is more abundant.

The best specimens, however, of that mineral occur in a bed of loose volcanic stones, which lie underneath the lava above noticed. When the crystals are capable of being detached from the matrix, they are generally found to possess the dodecahedral form, which in other localities is seen so imperfectly, well defined, and they are characterized moreover by gelatinizing with nitric acid, and by fusing into a blue glass with borax.

The blue kind found at Andernach, and in the Campagna di Roma, is less common here than the dark green variety, and owing to some external decomposition, the former is white superficially, and presents its natural colour only when fractured. It is accompanied with leucite, with augite, and with hornblende, and in the compact lava-bed which overlies the congeries of ejected masses described, I perceived concretions very much resembling the pearlstone of Hungary.

I am unable to discover, that mount Vultur has ever been measured barometrically, but that its height is very considerable there can be no doubt. At Frigento, which is nearly equi-distant from it and Vesuvius, the summit of Vultur appeared more conspicuously than that of Somma over the Appennine

ridge. Dr. Bouè, in his recent work entitled "Guide du Géologue Voyageur," assigns to it an elevation of only 1400 feet, but this is manifestly much below the truth. Its circumference is stated at about twenty-two miles.

It had been my original intention to return to Naples by another road, by Muro, Laviano, Oliveto, and Campagna, which traverses some of the loftier peaks of the Appennines, and would have brought us into that from Naples to Pæstum at Eboli.

But we were dissuaded from this undertaking, by the state of the weather, and the probable depth of the snow on the heights which we should have been compelled to pass.

On the other hand, the river Ofanto was so swelled by the rain which had fallen, as to justify the epithet of *violens Aufidus*, which Horace had applied to it:

> Dicar, qua violens obstrepit Aufidus,
> Qui regna Dauni præfluit Appuli,
> Cum sævit, horrendamque cultis
> Diluviem meditatur agris.

By waiting at Melfi, however, till the flood had in some measure subsided, we were enabled to ford the stream in safety; and our kind friend, the Cavaliere Aranco of Melfi, whose family had been unremitting in their attentions to me during my stay, enabled my Vetturino to drag the carriage through the mud intervening between the town and the high road, a distance of more than thirty miles, by lending me two good mules, in addition to the three horses which we had brought with us. We therefore returned by exactly the same road which had brought us out, and arrived the fourth day at

Naples, where we found a more genial sky, and a climate in every way contrasted with that we had experienced, either upon the Appennines, or round the skirts of that mountain chain.

I have now only to offer some general remarks on volcanos, as suggested by the phenomena which have just been described.

We may, in the first place, point out the existence of a line of country extending from the parallel of Naples to that of mount Vultur, along which volcanic action is developed under most of its different phases, according to certain variations in the external circumstances under which it occurs.

In Ischia, where the line commences, hot springs are abundant, and at distant intervals of time true volcanic operations have been observed.

At Vesuvius, close to the sea, ejections of stones and eruptions of lava are taking place continually; but when we follow the same line across the Appennines, we look in vain for any distinct indication of volcanic action, except at the Lago d' Ansanto, where the same gases are evolved, where a certain degree of heat seems to be generated, but where neither stones nor ashes have ever been thrown out.

Having traversed the Appennines, and descended its eastern slope, we perceive, standing in the same relation to that chain on the one side, which Vesuvius does on the other, a mountain similar in form and structure, but evincing no analogous phenomena at present, except the emission of carbonic acid and sulphuretted hydrogen, and those occasional rumblings of the earth beneath, which have been compared to subterranean thunder, and which, if the

natives are to be believed, take place most commonly when Vesuvius itself is in a state of eruption.

With such evidences of an internal communication, or at least of a sympathy between these two distant spots, what circumstances can be pointed out, to account for the almost entire quiescence of the one, and the determination of the volcanic energy to the other? One remarkable difference existing between them is, that, whilst Vesuvius is close to the sea, Vultur is thirty miles apart from it; yet, as we have seen, this difference may not have existed formerly, since the waters of the Adriatic, if they did not actually wash the sides of mount Vultur, once came within a short distance at least of its base.

And, when we examine the present condition of this volcano, we are led to carry back the date of its activity to a period at least as remote as that alluded to; for, so far from imagining it to have been burning in the times of the Romans, its condition seems to have been at that time but little different from that which at present belongs to it.

Horace would scarcely have selected it as the spot, where the doves are represented as covering him over in the days of his childhood with fresh leaves[1], had not the forests existed then in their present luxuriance; and, if the mountain had appeared to the poet under that arid and forbidding aspect which belongs to all volcanos that have been but a short time extinguished, he would have introduced some

[1] Me fabulosæ Vulture in Appulo,
Altricis extra limen Apuliæ,
Ludo fatigatumque somno,
Fronde nova puerum palumbes
Texere: Hor. Carm. iii. 4.

mention of such a circumstance, when he alludes to the peculiar features of the neighbouring places: the "excelsæ nidum Acherontiæ;" the "saltus Bantinos;" the "arvum pingue humilis Ferenti."

Lucan too speaks of the "arva Vulturis," without any allusion to the harsh and sterile appearance which belongs to a mass of recently ejected lava.

These indications of an extreme antiquity, compared to that of our earliest historical records, will not surprise those who are at all conversant with volcanic phenomena; and perhaps the extinct volcano of Rocca Monfina near Sessa, to the east of the road from Rome to Naples, furnishes an instance at least as remarkable. In the early history of Rome we read, that a war having broken out between the Sidicini and the Aurunci, the latter, through fear, deserted their city, and fortified Suessa, now called Aurunca, the present Sessa, whilst the walls of their former abode, and all that it contained, were destroyed by the Sidicini.

Some remnants, however, of these walls, I am assured, still exist—they are composed of lava, probably derived from one of the streams described by Breislac as having flowed down the mountain, a proof of their priority to the foundation of a city destroyed 334 years before Christ.

But a more decided proof of the antiquity of this volcano may be collected from the circumstance, that the ancient town stood on the brow of a hill, which constituted part of the margin of this very crater, and consequently that the crater which lies beneath it was then, probably in the same condition as at present, namely, covered with vegetation, so as to furnish the inhabitants with a pasturage for their cattle, and certainly not the scene of volcanic phe-

nomena, which would have precluded them from fixing upon such a site for their abode. Thus the period, at which this Volcano was in a state of activity, must be as remote as that, which we are disposed to assign to mount Vultur[m].

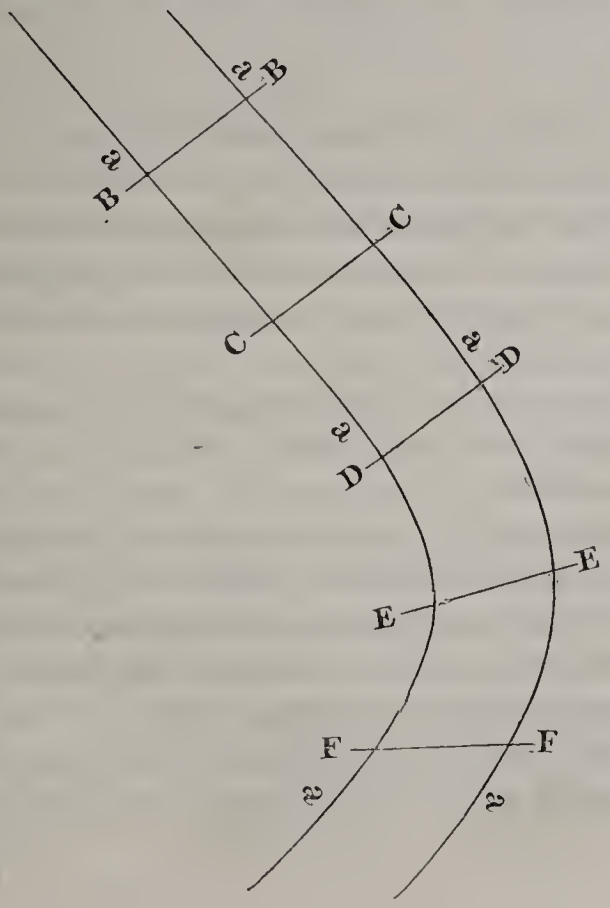
Such then are the volcanic phenomena met with in a direct line, but if we take in a somewhat greater breadth of surface, we shall include, on the side of the Mediterranean, the Islands of Ponza, and on that of the Adriatic, those of Tremiti, off the coast of Manfredonia, whilst the earthquakes under which Foggia and other cities have suffered, shew, that the same operations are carried on elsewhere in the neighbourhood.

In the annexed map I have stated the volcanic districts that occur nearly in a line either to the eastward or the westward of the country described, but I do not wish to lay much stress upon this coincidence of position as a proof of connexion between the more distant points, feeling, that there are perhaps few parallels of latitude, which do not present volcanic phenomena in some part of the globe or another.

I am more disposed to view the Italian peninsula,

[m] From a statement of Breislac's which I have quoted in my "Description of Volcanos," p. 137, it would follow that Rocca Monfina had been in action during the historical period, for it is there mentioned that the tuff on which the town of Sessa is built covers the remains of an ancient city, and amongst the rest, the vestiges of an amphitheatre. In my last visit to Italy I examined the spot, and found the buildings alluded to, but the amphitheatre, though considerably below the present town, seems to have been built in a natural hollow in the tufaceous rock, and never to have been covered over by that deposit; neither do the remains of another ancient building that has been detected, bear out Breislac's conclusion, which is moreover encumbered with so many difficulties, as to require the most overpowering evidence to establish its credibility.

as part of a long strip of country stretching from north-west to south-east, which is everywhere more or less subject to volcanic operations, but has here and there particular bands of greater intensity running at right angles to the former direction, or nearly from north-east to south-west. The first might be represented by a longitudinal band, the second by transverse lines intersecting it. Thus let a a a a represent the longitudinal band running from north to south of Italy, and thence extending to Sicily, and the transverse line B B will denote the line of greatest intensity stretching across Tuscany; C C that stretching across the Romagna; D D that from Naples to mount Vultur; E E that from the Lipari islands to the theatre of the Calabrian earthquakes; F F that from mount Etna to the new island of Sciacca.



APPENDIX.

Note at page 10.

I CANNOT, however, omit this opportunity of noticing two varieties of volcanic tuff which appear not to have been sufficiently studied, and which shew, that since the original ejection of the materials, their deposition at the bottom of water, and their consolidation into a mass of uniform consistency, changes have taken place in them, which the long continued operation of a moderate heat is perhaps most likely to have produced.

The first of these varieties is seen in the valley of St. Rocca, near the Capo di Monte, above Naples, where the tuff has been extensively quarried, and where large caverns are left in the rock, which, by exposing a considerable extent of surface, allow of our examining the structure on the great scale.

The most remarkable circumstance relating to it, is the existence of veins of a harder variety of the same rock traversing the bed. I call the matter of the veins a variety of tuff, because in some cases there seemed to be a passage from the ordinary kind into it, though in others the line of demarcation is very distinct.

In its hardest form it approaches nearly to porcelain jasper, is splintery, and has a conchoidal fracture. In these cases its surface is smooth, and its texture uniform, but when it is traced on, we discover in it a fragmentary structure, bits of obsidian, porphyry, pumice, and lapilli of various sizes and kinds being imbedded in the same paste. In other instances little veins of the same fragmentary variety of rock pass through the substance of the compact and uniform kind. The harder varieties of tuff, here described as veins, contain specks of mica disseminated through them.

Its surface is sometimes coated with a white incrustation, which seems to be siliceous.

It is seen to rest on a bed of the same volcanic materials, possessing however a very loose consistence, and composed principally of a congeries of grains of sand, and of lapilli.

Of this modification of tuff I know of no notice having been taken, excepting by professor Tenore of Naples, in his "Essai sur la Geographie Physique de Naples;" but the following is alluded to by Breislac and others under the name of Piperno, the name applied to it from one of the places where it has been found.

The spot in which I principally examined this latter variety, was the north side of the crater of Pianura, five miles from Naples. Like several other bason-shaped cavities that occur in the great tufaceous deposit overspreading that country, to which from the similarity of their form we are disposed to attribute the same origin, the sides of this crater exhibit no alternation of beds of lava and of ejected materials, or other traces of having been at any time the theatre of those eruptions of lava which occur at Vesuvius at present. They are composed indeed of the same volcanic tuff as that of Posilippo, with which this bed seems continuous, but the rock, which bounds the crater towards the south, for a certain distance upwards from the level of the hollow within, presents that character which has caused it to be designated by the popular name of Piperno.

Being extensively quarried for building purposes[a], galleries have been carried for a great distance into the rock, both horizontally and perpendicularly, and by means of the latter it has been ascertained that the same material extends at least forty feet beneath the level of the bottom of the crater. With respect to its external characters, Piperno may be described as a sort of volcanic breccia, bearing the same relation to the ordinary tuff, which Sienna marble does to an ordinary puddingstone, containing the same fragments of volcanic matter as the latter, but with the imbedded frag-

[a] It is used for the steps of houses, the sills of windows, &c. being more durable than tuff, and more easily cut than lava.

ments so blended with the cementing material, as to appear like a part of the same.

These fragments, which are sometimes without, but more commonly with cells, are often compressed and lengthened out in an horizontal direction, and are imbedded in a whitish paste, similar to ordinary tuff, but more compact. Indeed the beds of tuff that occur above it resemble much, except in hardness, the basis of the Piperno.

It is interesting to observe, that just over, and, as it were, passing into, this rock, is a tuff, with fragments of these several kinds of lava abundantly scattered through it, but existing in a state of very loose aggregation, excepting in the vicinity of the Piperno, where it becomes more and more compact, gradually passing into a perfect breccia. It is said moreover, that the best and hardest Piperno is taken from the bottom of the bed.

The impression which the appearances of Piperno created in my mind, was that of a bed of ordinary tuff, which after it had been originally deposited, was subjected to the action of heat under pressure, and in this manner underwent a kind of partial fusion. Under this condition of things, crystals of felspar, which are now abundant in it, as likewise the other minerals we occasionally meet with, although they did not previously exist, might be formed, and by the same agency the fragments disseminated through it might become blended with the surrounding matrix in the manner we find them to be.

There is yet another variety of volcanic tuff known in the Campagna di Roma and elsewhere, under the name of Peperino, which must not be confounded with the Piperno already described.

There is, however, thus far a correspondence between them, that Peperino is also a material which appears to have undergone certain intestine changes since it was first deposited, the effects of which have been to produce in the midst of the amorphous mass certain crystalline minerals, such as mica, augite, felspar, &c., and to impart a more uniform degree of compactness to the whole.

Whether these changes resulted from heat subsequently applied, may admit of dispute, but that here also some chemical operation or other has produced a fresh arrangement of the particles since the mass was originally formed, will scarcely be doubted by those, who admit that Peperino is a modification of the volcanic tuff found in its vicinity.

Yet even the latter, as seen at Posilippo, is more compact than the material known under the same name which has covered over Herculaneum, or which has resulted in other instances from the action of rains and torrents upon showers of ashes proceeding from modern eruptions.

Not that there is any original difference between the materials ejected, but that in the former instance the pressure of so much larger a bulk of matter, and probably also of the body of water, which for a time covered it, has caused a more intimate union between the several parts, and given it more of the character of an homogeneous rock.

Post Road to Apulia.

	Post.*
Naples to Marigliano	1½
(Thence to Nola, ½ post.)	
Marigliano to Cardinale	1½
Cardinale to Avellino	1½
Avellino to Dentecane	1½
Dentecane to Grotta Minarda	1½
Grotta Minarda to Ariano	1
Ariano to Savignano	1
Savignano to Ponte di Bovino	1½
(Hence by the cross-road, Melfi is about 5 posts distant.)	
Ponte di Bovino to Pozzo d' Albero	1
Pozzo d' Albero to Foggia †	1
Foggia to Passo d' Orta	1½
Passo d' Orta to Cirignola	1
(A bridge over the Ofanto, and a bridle road to Melfi.)	
Cirignola to S. Cassano	1
S. Cassano to Barletta	1
(Beyond Cirignola lies the field of Cannæ.)	
Barletta to Bisceglie	1
Bisceglie to Giovinazzo	1
Giovinazzo to Bari	1½
Bari to Mola	1½
Mola to Monopoli	1½
Monopoli to Fasano	1
Fasano to Ostuni	1½
Ostuni to S. Vito	1½
(Hence to Brindisi 1 post.)	
S. Vito to Mesagne	1½
Mesagne to Cellino	1½
Cellino to Lecce	1½
(Hence to Gallipoli 3 posts.)	
Lecce to Martano	1½
Martano to Otranto	1½

* N. B. A post is between 6 or 7 miles, but the Neapolitan mile is about 1¼ English.

† A Diligence twice a week from Naples to Foggia.

Th: Duclére delin. *J.W.Lowry sculp*

TOWN & CASTLE OF MELFI WITH Mt. VULTUR BEYOND.

SEEN FROM THE N.E.

Th. Duclère, delin. ~ Rock of Melfi. ~~ Mount Thabor. a.a.a. Compact Lava. b.b.b. Volcanic Tuff. J.W. Lowry. sculp.

VIEW OF THE TOWN & CASTLE OF MELFI.

Th. Ducière, delin. *J.W. Lowry, sculp.*

CRATER OF MOUNT VULTUR FROM THE S.W.

Volcanic Rocks of Ischia 38°
Lisbon 39°
Azores 40°

Volcanic Rocks of the Tremite Isles 40°
the Bosphorus 40° to 41°
Lemnos & the Troad 40°
Mt Ararat 40°
Central Asia 40° to 42°

MAP OF A PORTION OF THE KINGDOM OF NAPLES.

ON THE SITE

OF THE

ANCIENT CITY OF THE AURUNCI,

AND ON THE VOLCANIC PHENOMENA WHICH IT EXHIBITS;

WITH SOME REMARKS ON CRATERS OF ELEVATION, ON THE DISTINCTIONS BETWEEN PLUTONIC AND VOLCANIC ROCKS, AND ON THE THEORIES OF VOLCANIC ACTION WHICH ARE AT PRESENT MOST IN REPUTE.

BY

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ON THE SITE

OF THE

ANCIENT CITY OF THE AURUNCI.

THE lively interest, which, of all classes perhaps of physical phenomena, the operations of a volcano are best calculated to inspire, has been my principal motive for undertaking three journeys, at intervals of nearly ten years apart, to the south of Italy; on my return from each of which, I felt it a matter no less of duty than of inclination, to communicate some account of what I had observed, to such Members of my own University as felt any curiosity in researches of this description.

Accordingly, soon after I came back from my first visit to Italy in 1824, I submitted my views, with respect to the general nature and origin of volcanos, in some Lectures delivered in this place, which have been incorporated in a work afterwards published by me, but for some time past out of print[a].

[a] Description of active and extinct Volcanos, 1 Vol. 8vo. London, 1826.

In these Lectures I maintained, by an appeal, more particularly to the operations now proceeding, about Vesuvius, in Sicily, and in the Lipari Islands, that hypothesis, which was first propounded by Sir H. Davy, but which, towards the close of his life, that great chemist, like *an unnatural parent*, appears to have cast aside.

And although Dr. John Davy, in the Life he has published of his brother, has taken me rather severely to task, for venturing to suggest, that this *cruel abandonment of his own progeny* was, on the part of Sir Humphrey, a matter of taste, rather than of deliberate judgment, as though I had almost impeached his moral conduct by attributing to him such a change of sentiment on a scientific question,[b] yet I am still prepared to contend, that inasmuch as this illustrious philosopher, at the very time when he avowed his preference for a rival theory, acknowledged that the one he had originally advocated was adequate to account for all the phenomena which are known to accompany a volcanic eruption,[c] the opinion he expressed is not entitled quite to the same deference which it would otherwise command, nor to be regarded of sufficient weight to bias us against the reception of the evidence, which may be

[b] See Davy's Life, vol. ii. pp. 124, 5.

[c] Phil. Trans. for 1828, p. 250. "Assuming the hypothesis of the existence of such alloys of the metals of the earths as may burn into lava in the interior, the whole phenomena may be easily explained from the action of the water of the sea and air upon those metals; nor is there any fact in any of the circumstances which I have mentioned in the preceding part of this Paper, which cannot be easily explained according to this hypothesis."

offered in support of that hypothesis which I have ventured to espouse.

In my first visit then to Naples, my attention was almost exclusively directed, as that of most travellers is, to the operations of the active, or semi-active volcanos round about this Capital; but on my second, I extended my examination to an extinct one in Apulia, situated near the eastern declivity of the Appennines, and bearing, as it would seem, the same relation to the Adriatic, which Vesuvius does to the Mediterranean.

This volcano, known to the ancients as the Mount Vultur, a name which it still retains, preserves to the present day unimpaired the form as well as the structure of those portions of the earth's surface which have been once the theatre of igneous operations; the medium of communication, as it were, between the atmosphere and the interior of the globe.

Yet no manifestations of activity are recorded as having been exhibited by it during those periods of Roman History, when such phenomena would have excited attention.

On the contrary, it appears, from the testimony of Horace, to have presented then the same luxuriant vegetation, the same wooded slopes, which we observe at present, so that the inference seems inevitable, that the grand display of volcanic activity, which must have accompanied the formation of so considerable a mountain, was limited to a period long anterior to the existence of historical records.

Of this locality, as well as of the allied phenomena exhibited in a spot on the Appennines intermediate between it and mount Vesuvius, and

in a line parallel with both, called of old the lake Amsanctus, where, just as was the case nearly 2000 years ago, in the time of Virgil, copious volumes of carbonic acid gas are constantly given off into the atmosphere from some internal focus of volcanic operations, I gave an account on my return at one of the meetings of this Society, and the particulars are contained in a brief memoir since published in our Transactions. [d]

One other volcano however, or rather, I should say, another distinct system of volcanic operations existing within the Neapolitan territory, remained to be explored, I mean that of Rocca Monfina, near Sessa, at a distance of about 30 miles to the north of Naples.

This mountain accordingly it was my particular object, in the third and last journey I undertook to the south of Italy, to investigate, and as it proved in some respects more interesting, and more instructive, even than any of those which I had previously examined, I conceive that a brief account of it will form a suitable appendix to the reports on volcanic phenomena, which I have on former occasions presented at these Meetings. [e]

Those who have travelled from Naples to Rome by the lower and more frequented road, which passes by Mola de Gaieta, Fondi, and Terracina, may recollect, that after reaching Capua, they soon lose sight of the volcanic tuff or peperino, which

[d] Narrative of an Excursion to the Lake Amsanctus and to Mt. Vultur in Apulia, 1835.

[e] The little map appended gives the relative positions of the three volcanos alluded to.

constitutes the subsoil in all directions around Naples. They then find themselves upon a calcareous marl, which upon examination will appear to belong to the tertiary period, until they approach the hills which are ascended before arriving at the post house of St. Agatha. They there perceive that the rock is again a kind of tuff, but one possessing a different character, and therefore derived from another source from that surrounding Naples, and that it may be traced to a mountain called Rocca Monfina, which lies between the two towns of Sessa and Teano, one of which, Sessa, stands at a distance of about half a mile from the inn of St. Agatha already noticed, whilst Teano is situated on the eastern flank of the mountain looking towards the central chain of the Appennines.

Both these cities will be familiar to the readers of Livy, the first as Suessa Auruncorum, the last hold of the nation of the Aurunci, the second as the seat of the rival state of the Sidicini.

The Aurunci however, in the earlier periods of Roman history, had their capital at the summit, and not on the declivity, of the mountain. Though they at one time appear to have possessed themselves of a considerable tract in the level country both of Campania and of Latium, yet their original site was the hilly country intervening. Thus they are noticed by Virgil as a hardy race of mountaineers

> ——— et quos de collibus altis
> Aurunci misere patres.

and those who like myself have ascended the mountain, will regard it as admirably well adapted for the stronghold of a warlike and predatory clan.

We first read of them indeed, soon after the

expulsion of the Tarquins, as having formed a confederacy against Rome with two Latin cities, Pometia and Cora, when, being defeated with great slaughter, they are said to have taken refuge within the walls of Pometia. The following year Pometia was besieged without success, and one of the consuls being severely wounded, the invading army sounded a retreat.

A second army was however quickly dispatched, and Roman perseverance at length triumphed, Pometia being taken by assault, after which it was so completely destroyed, that though it had ranked as the principal town in the Pontine Marshes, to which indeed it gave its name, no vestige of it can now be discovered, and its very position is unknown.

Still the Aurunci remained unmolested in their capital on the summit of Rocca Monfina, to which the Romans, as it would appear, did not think it prudent to pursue them, and, although a few years afterwards, when this same people, in consequence of the taking of the town of Suessa by the Romans, joined the Volscians, they were again defeated in battle, their independance was still preserved to them within the range of the mountain fastness alluded to.

For the next century and a half the Aurunci appear to have kept aloof from collision with the Roman power, but in the year A. U. C. 410, they made a predatory incursion into the Roman territory, which excited so much alarm, from the fear lest, if unchecked, the whole Latin nation might rise, and make common cause with them, that a dictator was appointed to head the army sent to oppose their march. They were indeed promptly

repulsed, but nevertheless, in the great Latin war which commenced about five years afterwards, they again took part against the Romans, and shared in the defeat which attended the arms of the confederates.

At the peace which followed, they were admitted into the alliance of the Romans; but from this moment may be dated their ruin; for soon afterwards, the hostile nation of the Sidicini, either by surprise or treachery, effected that, which the Romans appear never to have attempted, namely, the expulsion of this people from their stronghold on the summit of Rocca Monfina, which, with its walls and fortifications, was utterly demolished, the inhabitants being compelled to seek refuge in the town of Suessa, the modern Sessa, in the plain below.

After this event, all we read of the Aurunci is, that they took part with the Samnites in their second war against the Romans, and in consequence of their defeat were obliged to submit to receive a Roman colony, so that their existence as a separate state was from this period destroyed.

That they should so long have resisted the Roman power, and not been finally subdued, until deprived of their original fortress on the top of Rocca Monfina, will be less a matter of surprise, when I have described the structure of this remarkable mountain.

After a rather steep ascent of about 2000 feet, we find ourselves all at once within a very regular crater, the brim of which is perfect on the west, where it forms the lofty and precipitous Monte Cortinella, and may be traced in other parts throughout its entire circumference, except on the

side which we enter on coming from Sessa, where it is so far broken away, that there is scarcely any sensible descent before arriving within its precincts. The circular form and extent of the crater is however better observed from some point near to its centre, than from its margin, and a remarkable conical protuberance which rises up from the midst of the crater, and reaches an elevation of 3200 feet [f], considerably exceeding the highest point which the margin of the latter attains, gives us an excellent opportunity of surveying its internal dimensions.

Its diameter is estimated at two and a half Italian miles, and its circumference at seven and a half, but a large portion of its interior is occupied by the conical hill above noticed, the structure of which I shall describe immediately.

It is no novelty to the traveller in Italy, to observe the country increasing in verdure and fertility, in proportion as he ascends to a higher elevation, so that, after toiling up a laborious ascent, unapproachable perhaps, except on foot, or by beasts of burden accustomed to mountain paths, he may often find himself all at once in a valley, exhibiting, instead of the sombre and lonely aspect which in colder countries is characteristic of mountain scenery, a display of those softer and lovelier features, which the intense heat of the sun soon banishes elsewhere from the landscape of southern latitudes, and teeming with a population, more healthy, more vigorous, and apparently more thriving, than he had left in the plain below.

Such is found to be the case in crossing the

[f] Abich, über die Natur &c. der vulkanischen Bildungen. Braunschweig, 1841.

mountain chain that separates Amalfi from the towns that lie scattered along the Bay of Naples, after we have climbed up the flights of rude steps, which often form the only medium of communication between the villages situated on the slope of the hill, and the sea that flows at its base.

And in like manner, Rocca Monfina, isolated as it may appear, and remote from any great thoroughfare, comprehends within its precincts two or three populous villages, several churches, and more than one convent; whilst its surface, so far from presenting the rugged aspect which volcanic rocks usually assume, is so uniformly clothed with vegetation, and in a state of such complete culture, that, but for the amphitheatre of hills which encloses the table-land on its summit, the circular form of which betrays the origin of the mountain of which it forms the outer margin, no one could for an instant dream, from its general physiognomy, that the whole was of igneous formation.

And yet, when we look back to the accounts given by the Roman writers of the state of Vesuvius, or rather of Monte Somma, just before that mountain returned to a state of activity in the second century of the Christian æra, we may see reason to believe, that its condition must then have been nearly similar to that of Rocca Monfina at present[g], if we only except the crater, which, not being composed of tuff, was entirely barren, even in the time of Strabo[h].

[g] See the Engravings which represent, the supposed form of the mountain in the time of Strabo, and its appearance subsequently to the time of Pliny.

[h] See Martial IV. Ep. 44. Strabo, V. 24.

In one respect indeed even here the analogy held good; for like the crater of Rocca Monfina, that of Monte Somma seems to have been broken away on one side, by which the troops of Spartacus must have entered it when besieged by the Roman legions; and it was by climbing up the sides of that portion which continued entire, that the army alluded to contrived to escape from their dangerous position, and to take the enemy in the rear[i].

If such then was the condition of Rocca Monfina during the early periods of the Roman Republic, we can hardly imagine a position better calculated for the stronghold of such a nation as the Aurunci are described to have been.

Their outpost Suessa, situated, as we have seen, near the bottom of the mountain, commanded the approach to it on that side where it was most accessible, and secured to them a communication, with the sea, with the cities of the Pontine Marshes, and with their possessions in Campania.

If driven from thence, they had only to retreat to the summit of the mountain, where, posted on the external margin of the crater, they would watch the movements of any invading force, long before it could gain the top of a mountain of such height, and so difficult of access. In case of an attack, they could drive their flocks and herds within the crater, where they would find ample space and good pasturage, without danger of molestation, unless indeed the invading force were powerful enough to dislodge them from the vantage ground, which their army would occupy on the brim of

[i] Plutarch, in vit. Crassi. Florus, III. 20.

the crater, itself a natural fortress, inclosing within its ample boundaries a large tract of fertile land.

Even if forced to relinquish this stronghold, they still had it in their power to take refuge on the conical and precipitous mountain which rises up from the very centre of the crater, where a small force might easily set at defiance a host of invaders.

On this mountain, called, from a cross which till lately stood on its summit, the Monte de la Croce, they accordingly appear to have placed their citadel; for an Italian archæologist[k] first pointed out, on a level spot nearly at the top of this eminence, as vestiges of the ruined city, pavements of streets, corners of apartments, foundations of buildings, three cisterns for containing water, together with heaps of hewn stones, and remnants of very strong walls.

Some of these were perceived by myself in the course of my rambles over the mountain, and I found that they consisted of the same material which composes the rock on which they had been erected.

No better proof than this could be adduced of the antiquity of the volcanic operations to which the mountain owes its actual configuration; for, as sir William Gell observed to me, when I once descanted with him on the extreme disproportion which exists between the length of period embraced within the several epochs of human and geological history, a nation like the Aurunci, to whom it was of essential importance to have near their city good pasturage for the flocks and herds on which they depended for

[k] Perotta, Sede degli Aurunci, as quoted by Romanelli, vol. iii. p. 444.

support, would never have selected Rocca Monfina for their capital, not only if the volcano itself had been in activity, but had not the stone which constitutes the interior of the crater been already in such a state of decomposition, as to be covered with herbage, and to yield abundant crops.

With regard to the geological structure of the mountain, I may remark, that with the exception of the conical mass of rock in its centre which constitutes the Monte della Croce, it is almost entirely composed of beds of volcanic tuff, which differs however from that met with round about Naples, in the inferior degree of its compactness, in its more earthy appearance, in the more frequent presence of mica, and the rarer occurrence of the darker varieties of pumice.

I remarked a red ferruginous variety of tuff, sometimes in beds alternating with the commoner kinds, and in one instance forming a kind of vein running vertically through the strata.

The tuff continues from the town of Sessa till we approach the outer brim of the crater, covered over with loose uncompacted aggregates of volcanic sand, and of stones promiscuously heaped one upon the other.

In this tuff are often imbedded, not only its usual concomitants, sand and rapilli, but also large blocks of a kind of porphyry, peculiar, as it would seem, to the products of the ancient volcanos of Monte Somma and of Rocca Monfina in the Neapolitan territory, and of Acquapendente and Viterbo in the Roman, characterised by crystals of leucite, which, at the spot now under consideration, are often of

extraordinary dimensions, sometimes two inches and a half in diameter, and are accompanied by minute crystals of augite, both imbedded in a felspathic basis. As the felspathic portion was more readily decomposed than the imbedded crystals, these latter might often be detached from their matrix in a state of great integrity.

Near the little village of Tuoro de Sessa, which is situated very little below the external margin of the ancient crater, we observe a continuous bed of this leucitic porphyry, resting upon the tuff, and extending for some distance along a ravine which runs obliquely down the sides of the mountain. This was the only instance that occurred to me, in which the above rock appeared in any other form than that of detached blocks.

The most remarkable feature however in the physiognomy of this mountain, and that which distinguishes it from every other volcano I had seen, is the protrusion from the interior of the crater of a conical mass of a rock resembling trachyte[1], large enough to fill up two thirds of the area comprehended within the walls of the crater, and so lofty as to rise considerably above the most elevated point in its margin; constituting indeed, when observed from a distance, the most conspicuous object embraced within the compass of the mountain.

[1] See the Section and Ground Plan of Rocca Monfina, the former reduced from a sketch taken by the artist who accompanied me on my visit to the mountain; the latter borrowed from a Memoir by Professor Pilla, who however has represented the crater as though it were entirely effaced on the east, whereas it appeared to me there distinctly traceable, although undoubtedly much lower than it was on the west.

This trachytic rock is much more abrupt than the tuff through which it appears to have been protruded. In its centre is a hollow plain, which may possibly have once been a kind of crater, as there are still on three of its sides points of rock that rise considerably above the central concavity, of which the highest was formerly marked by a cross; a circumstance which, as I have stated, served to give the name of Santa Croce to the entire mountain.

The rock is generally of a reddish brown colour, its base sometimes gray, fine-grained and compact, but not of very close texture, intimately interwoven with small felspathic portions, which frequently shew a glassy fracture, as if from fusion.

Much green augite, never however accompanied by even a trace of hornblende, penetrates the whole mass, and brown mica, generally in hexagonal tables, is a predominant ingredient. Abich regards the rock in the aggregate as forming a link intermediate between trachyte and greenstone.

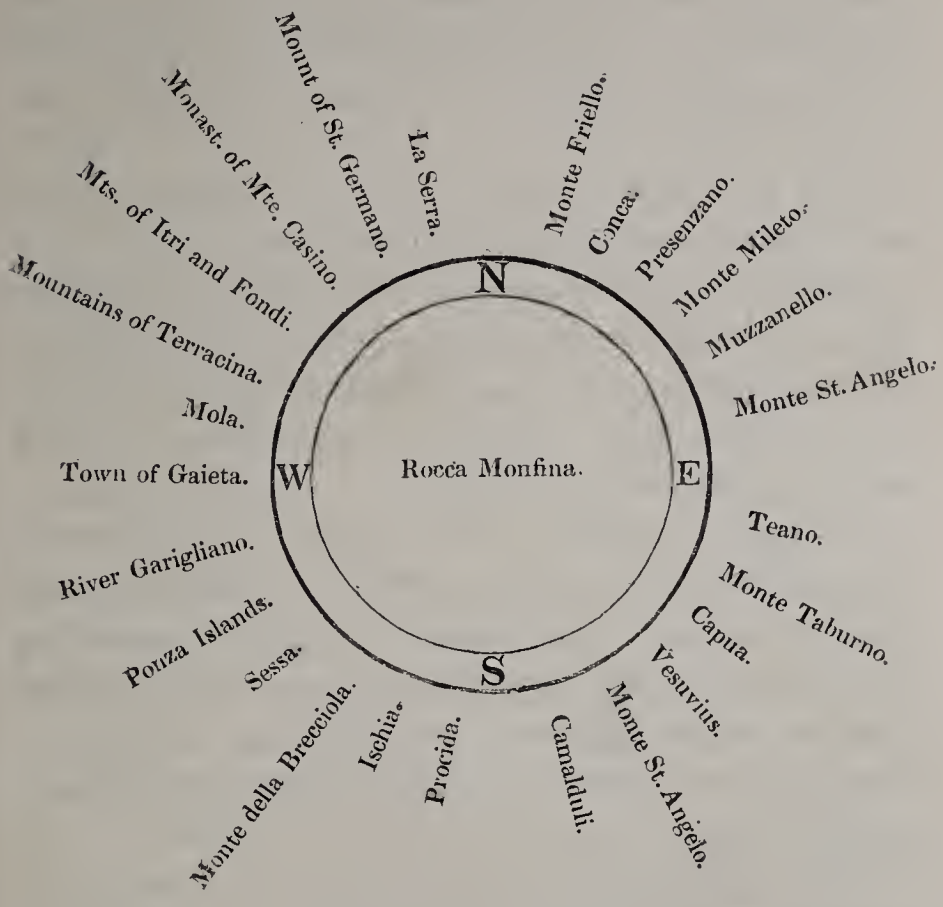
Pilla informs us, that the summit of this cone is exactly equidistant from all parts of the crest of Monte Cortinella, the only portion of the original crater that stands absolutely intact, shewing, that it stands exactly in the centre of the inclosed area; a singular and improbable coincidence, unless it had upheaved the rest of the mountain, but one presenting no difficulty if we admit this supposition.

The rock alluded to, abrupt as it is, seems to be everywhere covered over with vegetation, and a fine chestnut forest occupies a considerable portion of its flanks.

From its summit the eye embraces, on the one hand, Mola di Gaieta, the range of mountains termi-

nating in Cape Circello, and the whole extent of coast as far as Ischia and Vesuvius; whilst on the other, the line of the Appennines, including the monastery of Monte Casino, and other places built upon the slope of these mountains, appears conspicuous.

The artist who accompanied me executed, from this and other points of the mountain under consideration, a panoramic view of the whole circuit which the eye comprehends, of which the following ground plan may serve to present some idea:



Now the circumstance which, in a geological sense, attaches the highest interest to the structure of this mountain, is the support which it appears to afford to the *theory of elevation;* the view, that is, which regards volcanic mountains, as formed in the first instance by such a sudden upheavement, as might have brought the masses of rock of which they consist, from a nearly horizontal position, into their present inclined one, and at the same time caused them to occupy a much higher relative level than they had done antecedently.

This view of the original formation of volcanic mountains has been maintained by some of the most distinguished of modern geologists; by Humboldt, by Von Buch, by Elie de Beaumont, by Dufrenoy, and by Abich.

But as it has met with able opponents, in Lyell and Scrope in this country, and in Mons. Prevost in France, it is satisfactory for those who adopt such a theory, to be able to justify their belief in it, by pointing out facts, which, like the *experimenta crucis* in chemistry, seem irreconcilable with any other hypothesis.

Of this description, as it appears to me, is the protrusion of a compact mass of trachytic rock through the centre of a mountain mainly consisting of materials so different from it, as leucitic porphyry and volcanic tuff; and its attaining moreover a height so considerable, as it has done in the instance before us.

The first difficulty in the way of supposing it formed by the same operations as those which produced the mass of the surrounding mountain, arises

from the constitution of its component parts, which is such as to imply a different origin for the two. Moreover it may be remarked, that if the Monte della Croce had consisted of heaps of incoherent scoriæ, or of large fragments of slaggy lava piled one above the other, like the cone which is now forming in the centre of the crater of Vesuvius, its existence might then indeed have been explicable by an appeal to the every day operations of which we are eyewitnesses in volcanos now in activity.

Had it even formed part of a stream of lava, which might still be traced down the external flanks of the mountain, although we should have wondered at its ample dimensions, we might nevertheless have referred it to the same cause; but a conical mass of rock so considerable, and yet so completely circumscribed within the area of the crater, could only, as it would seem, have been brought into the position which it is seen to occupy, by being upheaved *all at once* from the interior of the globe, whilst in a semi-fluid or pasty state, but not in a condition of actual liquidity.

We have therefore before us an Agent, which would not only be competent to uplift the surrounding strata of tuff, but which must necessarily have done so, if the latter had been at the time of its eruption in an horizontal position; and to suppose them gradually formed by successive showers of loose incoherent ejected materials, before the trachytic rock in its centre was protruded, seems to imply a forgetfulness of the height which the tuff has attained, and of the high angle at which its beds are inclined.

Alternating strata of tuff and lava may indeed be imagined to build up in the course of time a mountain of considerable elevation, but a hill consisting of tuff alone, as appears to be the case with a large part at least of Rocca Monfina, could only have attained its present height, which is at least two thousand feet above the sea, in consequence of some elevatory movement subsequent to its ejection; and if this be admitted, we have before us in the central trachytic rock of Monte della Croce, an agent calculated to cause such an upheavement, and itself hardly to be accounted for without such a supposition.[m]

I have not time at present to enter into the general discussion of the subject, and will therefore only allude to two facts relating to the volcanos of Etna and Vesuvius, which seem to shew that even there, where analogy would most lead us to suppose that the whole of either mountain has

[m] Although Rocca Monfina presents the best instance with which I am acquainted, of a trachytic rock that has protruded through the centre of a crater, without forming a current of lava extending down the external slope of the mountain, yet we have something of the same kind in the crater of Astroni, and, on the road from Rome to Florence, we may observe near Rosciglione, in the Lake of Vico, the Lacus Cimini of antiquity, and an undoubted crater, a conical hillock rising from its centre, the real structure of which is concealed from the passing traveller by being covered over with trees, but which may very probably be of similar formation.

Amongst extinct volcanos however a still more striking parallel is presented in Auvergne by the Puy de Dome, a conical mountain consisting of that friable description of trachyte called domite, which rises from the midst of an amphitheatre of volcanic rocks of quite a different character from itself, and of a much darker colour from the intermixture of augite. See my Work on Volcanos.

been formed by a succession of the same ejections which are continuing to increase it, the stubborn evidence of facts compels us to adopt the elevatory theory.

The first of these facts is the circumstance so lucidly pointed out by Elie de Beaumont, and substantiated by him through a most laborious induction of particulars; namely, that a stream of lava, having an inclination of more than six degrees, cannot form a continuous mass, and therefore that the upper portion of Mount Etna, which rises with an inclination of 29° and 30°, must have been produced in some other way.[n]

The second is the discovery of the same marine shells in the tuff of Monte Somma which exist in that of the Phlegrean fields[o]; seeming to shew, that the former, as well as the latter, had once been

[n] See also Von Buch on volcanos and craters of elevation, Edin. Phil. Journ. vol. xxxv. for Oct. 1836.

[o] Professor Scacchi, in the Guida di Napoli (a valuable present made by the king of Naples to each of the Scienziati who attended the Italian Congress held at his Capital in the autumn of last year) enumerates the following shells as existing amongst the erratic blocks of Monte Somma, some of which he states also to occur in the tuff of the same locality.

	Marl.	Lime-stone.		Marl.	Lime-stone.
Pecten Jacobæus	+	+	Cardium echinatum	+	
——— varius	+		——— tuberculatum	+	+
——— sanguineus	+	+	Volvaria triticea	+	
Ostrea cristata	+		Buccinum mutabile		+
Nucula margaritacea	+		——— macula		
Mytilus	+		Pleurotoma varia		
Solen legumen		+	Scalaria communis	+	
Tellina donacina		+	Turritella communis	+	
Tellina exigua		+	Natica Valenciennerii	+	
Erycina Renieri		+	Dentalium dentalis	+	
Corbula nucleus	+		——— coarctatum	+	+
Mactra stultorum		+	Siliquaria anguina	+	
Venus exoleta	+	+	Serpula cereolus		+
——- Chione		+			

under water, and consequently could only have attained their present elevation by being upheaved.

The reluctance indeed which certain eminent geologists in this country have evinced to the admission of this theory, seems to have proceeded from an undue reliance upon the truth of their favourite principle, that all the phenomena on the earth's surface, which geology has revealed to us, are brought about by a repetition of the same cycle of operations which we are eyewitnesses of at present—that in the natural, as well as in the moral world, there is a kind of circle of events continually reproducing each other, and bringing us back after an interval of time to our original starting place.

For my own part, I am inclined to think, that the analogy of the moral world might lead to more hopeful conclusions; the laws of matter indeed, like the passions and capacities of man, have at all times no doubt continued the same, but it does not therefore follow, that the former may not have produced different effects in ancient times, by operating upon a different condition of the external world, and that the same series of events which we witness at present, must have taken place formerly, or will be repeated hereafter; any more than we need anticipate the recurrence of the same conditions of civil life which we read of in ancient history, or deny, that in the midst of continual alternations of retrocession, as well as of advancement, the general tendency of human society is in the direction of progress.

Waving however these general considerations, I

will just point out certain facts which seem to demonstrate, that these geologists must, in spite of themselves, admit of processes, which, though all included under the general category of igneous operations, are nevertheless distinguished from those brought about by the influence of subterranean heat at the present time, and of which therefore they can have no actual experience.

Few of us in the present day will question the igneous origin of granite, and least of all those belonging to the school of geology to which I allude; it is impossible indeed to conceive, in what manner the particles of silex, alumina, and alkali, composing this rock, could have been brought into such close juxta-position, as to be able to exert their mutual affinities, and to form crystals of felspar and mica, unless the mass had been in a state which admitted of a certain freedom of motion in its constituent elements, for which an approach to a state of fluidity seems absolutely requisite, whilst for this fluidity we know no other probable cause than heat.

Nevertheless it is an undoubted fact, that on the one hand the igneous operations, whose effects we witness, have never been found to give rise to ejections of granite; and on the other that those extensive rock formations, apparently resulting from igneous processes, which, themselves destitute of all traces of organic life, lie at the base of those strata which contain the earlier manifestations of the same, and are therefore considered to have preceded them, never present to us

the characters either of sub-aereal, or of sub-marine volcanos, whether we regard their geological structure, and relations to other rocks, or their constitution, as determined by chemical analysis. For the first element in the consideration I would appeal to the testimony of Professor Keilhau of Norway, who, by a long series of elaborate observations, has at least succeeded in shewing the difficulties of identifying granitic rocks with modern igneous products, and I am happy to find Sir Roderick Murchison, in his recent work on Russia, adding the testimony of his extended experience to the soundness of those views with respect to the *primogeniture* of granite, which were prevalent in the earlier times of geology. For although its occurrence superimposed on secondary and even on tertiary strata cannot be denied, yet it does not therefore follow, that those extensive formations of the same kind, which lie below the most ancient fossiliferous rocks, are to be placed with them under the same category.

We may therefore appeal to the production of a granitic compound, as an example of a mode of igneous operation, differing from any which we witness at present, and brought about under conditions which seem in the later periods of the earth's history to be, to say the least, but of unfrequent occurrence.

But this is not all, for by reference to the discoveries of modern chemistry we shall be enabled, if I mistake not, to trace a very beautiful series of transitions, by which the primæval granite has been

converted, first into trachyte, and afterwards into the various kinds of lava, &c. which characterise modern volcanos.

On this point I will enlarge a little, as a full explanation of it may tend to impart to you, as it has done to myself, clearer notions as to the real nature of the products which we are accustomed somewhat vaguely to designate under the names of granites, trachytes, and the like.

Ask, for instance, a geologist what he means by the term granite, and he will tell you, that he understands an aggregate of three minerals, namely quartz, mica, and felspar, in a state of intimate mixture.

But in order to learn what these several minerals really are, the chemist is the fittest person to be consulted, and from him we may collect, that quartz is nearly pure silex coloured by indefinite, but minute, quantities of certain foreign matters, but that mica and felspar are definite compounds, formed of an acid and a base in exact atomic proportions. The same indeed applies to all crystallized minerals consisting of more than one ingredient, as was first laid down by the illustrious Berzelius—a generalization, by the by, which ranks perhaps, next to the great Daltonian law of definite proportions, highest in the scale of importance amongst scientific truths of this class, and was arrived at by him at a time when so many difficulties lay in the way of its adoption, that we cannot sufficiently admire the penetration required for its discovery, as well as the boldness which he evinced in promulgating it. Indeed, until the celebrated Prussian chemist Mitscherlich had developed his original views on the

subject of what he has called Isomorphism, we were stopped at the very threshold of Berzelius' theory, by finding the same mineral to contain, sometimes one base, sometimes another, without any other apparent limitation, except that the proportions they severally bore to each other should be as their atomic weights. Thus garnet might contain alumina, peroxide of iron, lime, magnesia, protoxide of iron, severally combined with silica, or any one or more of these bases might be absent, provided only there was one base with three atoms of oxygen combined with two of the negative element, and another with one atom of oxygen united with one of the latter, present in the compound.

The difficulty which this occasioned was however removed, when Mitscherlich had shewn, that several bases admitted of being substituted one for the other without destroying the essential character of the crystallization, or producing any further change in it than a slight difference in the angle; the only necessary condition being, that each of the bases so replacing each other should contain an equal number of atoms of oxygen. Thus potass, soda, lime, magnesia, protoxide of iron, &c. may replace each other, as containing each an atom of oxygen, to an atom of the radical present; as likewise may alumina, peroxide of iron, and peroxide of manganese, since they each contain three, to two of base, so that the same mineral admits of a considerable diversity of composition, whilst still retaining its own peculiar crystalline form [p].

[p] Rammelsberg, a disciple of Rose, has proposed a chemical classification of siliceous minerals founded on this principle, which

But later researches have carried us a step further; they shew that crystallographers have often confounded several minerals, which analysis proves to be distinct; thus Henry Rose of Berlin, and other chemists of the school of Berzelius, proved, that whilst one kind of mica contains a certain definite amount of potass, in another a portion of that base will be replaced by lithia, and in a third by magnesia.

In the two first the mineral, when examined by polarized light, exhibits only one axis of double refraction, or one set of rings, whilst in the last it displays two such sets, so that the magnesian mica deserves to be distinguished as a separate species on crystallographical grounds alone.

In like manner Henry Rose has asserted on the faith of chemical analysis, that mineralogists had designated by the name of felspar several distinct substances, a statement, which the more exact examination of their respective angles of crystallization has since proved to be correct.

There is indeed such an analogy between them with respect to their chemical composition, as well as to their external characters, that they may perhaps be conveniently considered as different species of the same genus, to which the term felspar is applicable, the new terms which have been affixed to them by way of distinction being regarded as designating the species.

I shall give in the Appendix, as it seems to me the best attempt that has been made, to reduce to order the confused mass of species containing various proportions of these earths which mineralogy presents.

Thus the genus felspar may be defined as indicating a mineral, the primary form of which is an oblique rhombic prism, and its chemical constitution that of two compounds of silica united together; the first consisting of silica united with any base which contains only one atom of oxygen, the second compound of silica, one where that body is united to a base in which the proportion of oxygen to the radical is as three to two.

But this definition gives scope for a considerable diversity of chemical composition, since silica is capable of entering into chemical union with bases in the proportion of one, two, and three atoms, and accordingly I may enumerate the following species of the felspar family as distinguished by Rose and his disciples. In this enumeration however I will endeavour to simplify the matter as much as possible, by pointing out in the first place merely the relation which the silica bears to the base which contains three atoms of oxygen to two of radical, and in order to avoid an inconvenient circumlocution, will speak of this base, as though it were *in all cases* alumina, that being the negative element possessing the above composition, which is most commonly found in union with silica in this class of minerals.

In anorthite then, and in labradorite, the silica is to the alumina in the proportion of atom to atom, the difference between these two minerals consisting, in the former being composed of three proportionals of this combination; in the latter of only one.

In the andesin, or the felspar from the Andes,

as well as in oligoklase, the silica is to the alumina in the proportion of two to one; the difference between the two consisting in the proportion which the silica bears to the base with one atom of oxygen.

Lastly, in pericline, albite, glassy felspar, adularia, and orthoklase, the proportion of silica to alumina is as three to one, the largest amount in which it is capable of entering into chemical union with any base whatsoever.

The chemical differences between these four minerals consists in the nature of the base with one atom of oxygen united to silica, which it contains; this in orthoklase is chiefly potass; in albite wholly soda; in pericline partly potass but chiefly soda; and in adularia chiefly potass, though a small amount of soda is also present.

Thus we have in the felspar family three several gradations in the proportion which the silica bears to the alumina with which it is combined, namely, one, two, and three atoms to one of base, as may be seen by the following table, for which I am indebted to Abich.

It is observable that the specific gravity of the mineral is, in these cases, as well as in most other of the products of igneous action, inversely as the amount of silica, and directly as that of the other bases, so that a near approximation may be often obtained to their chemical composition by merely ascertaining their weight.

This accordingly is the method proposed by Abich, in order that we may appreciate the real mineralogical composition of a rock, in which the component parts are so blended together, that it

is impossible to separate one from the other for the purpose of examination.

In these cases the specific gravity will often give the proportion of silica, supposing iron and other of the heavier metals not to be present in quantity sufficient to affect the result, and from the proportion of silica the nature of the felspathic mineral present may be in general estimated with sufficient precision [q].

Now it is important to observe, that the kinds of felspar commonly found in granite are those which contain the largest proportion of silica, namely either orthoclase, adularia, or albite. Where, as is often the case, orthoclase and albite are both present, the basis is generally composed of the latter, whilst the imbedded crystals consist of the former.

Such is the case at Carlsbad, and this fact affords perhaps the true solution of a question

[q] Thus, Trachytic porphyry, having a specific gravity of 2.5783 contains of silex 69.46 per Cent.

Trachyte	2.6821	—	65.85
Domite	2.6334	—	65.50
* Clinkstone	2.5770	—	57.66
Andesite	2.7032	—	64.45
* Glassy andesite	2.5851	—	66.45
Trachyte-dolerite	2.7812	—	57.66
Dolerite	2.8613	—	53.09

The only exceptions being clinkstone and glassy andesite, the former having the same composition as trachyte-dolerite, but an inferior specific gravity; the latter corresponding nearly with clinkstone in both these particulars. It is to be remarked however, that clinkstone, although chemically resembling trachyte-dolerite, has a different mineral composition, for it appears to be a mixture of a zeolitic mineral with glassy felspar. Probably the same may apply to glassy andesite.

Tabular View of the Chemical Constitution, Specific Gravity, &c. of the Mineral Species comprehended in the Felspar Family.

Name.	Locality.	Sp. Gravity.	Principal Constituents.					Formula.
			Silica.	*Alumina.*	*Lime.*	*Potass.*	*Soda.*	
1. Anorthite	Monte Somma	2.7630	43.79	35.49	18.93	0.54	0.68	$\dot{R}\,\ddot{Si} + 3\,\ddot{\underline{R}}\,\ddot{Si}$
2. Labradorite	Mount Etna	2.7140	53.48	26.46	9.49	0.22	4.10	$\dot{R}\,\ddot{Si} + \ddot{\underline{R}}\,\ddot{Si}$
3. Andesin	Popayan, Andes	2.7328	59.60	24.28	5.77	1.08	6.53	$\dot{R}^3\,\ddot{Si}^2 + \ddot{\underline{R}}\,\ddot{Si}^2$
4. Oligoklase	.. ..	2.6680	62.61	24.11	2.74	0.75	8.89	$\dot{R}\,\ddot{Si} + \ddot{\underline{R}}\,\ddot{Si}^2$
5. Perikline	Pantellaria	2.6410	67.94	18.93	0.15	2.41	9.98	
			68.23	18.30	1.26	2.53	7.99	$\dot{R}\,\ddot{Si} + \ddot{\underline{R}}\,\ddot{Si}^3$
6. Potass-albite	Drachenfels	2.6223	70.22	17.29	2.09	3.71	5.62	
7. Albite	.. ..	2.6140	69.36	19.26	0.46	?	10.50	
8. Ryakolite	Monte Somma	2.6180	50.31	29.44	1.07	5.92	10.56	$\dot{R}\,\ddot{Si} + \ddot{\underline{R}}\,\ddot{Si}$
9. Glassy (or Soda) Felspar	Ischia	2.5970	66.73	17.56	1.23	8.27	4.10	
10. Adularia	St. Gothard	2.5756	65.59	17.97	1.34	13.99	1.01	$\dot{R}\,\ddot{Si} + \ddot{\underline{R}}\,\ddot{Si}^3$
11. Orthoklase	Baveno	2.5552	65.72	18.57	0.34	14.02	1.25	
12. Artificial Felspar	Made at Sangershausen	2.5600	65.03	16.84	0.34	15.26	0.65	

N. B. The first seven Species belong to the *ein und eingliedriges Krystallsystem* of Weiss, or the *anorthotype* one of Mohs, the axes of crystallization being unequal, and not mutually related: whereas the last five Species belong to the *zwei und eingliedriges System* of the former, and the *hemiorthotype* of the latter, two of the unequal axes bearing a certain relation to each other, so as to constitute a pair.

which I started in my Report on Mineral Waters, (British Association Reports, vol. v. 1836, p. 24.) namely, why these and other thermal springs which issue from granitic chains, hold carbonate of soda in solution, but not carbonate of potass.

Now by considering the nature of its felspathic material, it being one of those varieties of the mineral in which the silica is in the proportion of three atoms to only one of base, we may see the reason, why in granite a certain proportion of quartz, or uncombined silica, is almost universally present.

Its amount in fact represents the excess of silica existing in the rock over and above that which could combine with the alumina, and hence it implies, that at the time, and at the place, where the granite was formed, there was not a sufficient quantity present of the several bases to combine with the whole of the silica.

And if we examine the composition of the various rocks which have been produced by the operation of volcanic forces in ancient and in modern times, we shall be able to trace a gradual scale of diminution in the proportion of silica, and a corresponding increase in that of the bases present.

The first great division of them is comprehended under the name of trachyte, a general term for a class of rocks of igneous formation characterised, mineralogically by their harsh and gritty feel, together with the frequent presence of crystals of glassy felspar, and chemically as being trisilicates, with or without an excess of silica.

They are divided by Abich, who follows in a great degree the classification of Beudant, into

1. Trachytic porphyry, in which quartz is present, but neither hornblende, augite, nor titaniferous iron appear. It is found, not only in Hungary, but also in the Ponza, and in some of the Lipari islands.

2. Trachyte properly so called, in which no quartz occurs, but which contains crystals of hornblende and even of augite, together with mica.

3. Andesite, the trachytic rock of the Andes, described by Abich as being of various degrees of compactness and consistency, possessing a coarse conchoidal fracture, and containing a large number of small white crystals, resembling albite, in a crystalline base of a darkish colour. Small crystals of glassy felspar are rare in this variety of trachyte, but those of hornblende are common, and augite is also present. It sometimes passes into greenstone or diorite.

Thus the rock composing the summit of Chimboraço, the basis of which resembles pitchstone, and which is destitute of hornblende, though rich in augite, is called by Von Buch an andesite. Antisana also, and Cotopaxi are said to consist of the same, and it is probable that this rock, in connection with trachyte properly so called, constitutes the greater part of those volcanic mountains in South America which are destitute of craters.

4. Obsidian and pumice, which are so connected, both physically and mineralogically, that they must be placed under the same head, and regarded merely as expressions for two different conditions which the same original material has been made to assume, by the agency of volcanic forces. Both indeed have been regarded, rather as particular states which many

different minerals are capable of assuming, than as distinct species; but it is to be remarked, that simple silicates and bisilicates of alumina are incapable of assuming, either a vitreous condition such as that of obsidian, or those cellular and filamentous forms which we observe in the different varieties of pumice.

It is necessary therefore that the rock should be rich in silica, or be a trisilicate; and hence if with Abich we divide pumices into two groups, namely into cellular and filamentous, the former being dark green, poorer in silica, and richer in alumina; the latter white, and containing more silica; we shall find that the former is derived from clinkstone, trachyte, and andesite, and the latter from trachytic porphyry[r].

5. Pearlstone, a rock frequent in Hungary, and characterised by the presence of crystallites, or little globular concretions more or less vitreous, and generally scaly, with a pearly lustre arising from the commencement of a kind of crystallization in the mass, or where this is wanting, passing into a stony structure, or into a semivitreous one corresponding with that of pitchstone, which latter mineral seems to be nearly allied to it.

5. Trachytic tuff, the principal rock covering the Phlegrean fields, the analysis of which proves that it is, like pumice, only a metamorphosed condition of trachyte. Thus tuff, pumice, and obsidian are all modifications of the same volcanic basis; and all, except obsidian, contain water chemically combined —yellow tuff three atoms—white tuff two atoms—pumice one.

[r] For further remarks on the formation of obsidian and pumice, see Appendix.

We must therefore regard the three former, as caused by water operating in a different manner from the steam which accompanies a flow of lava, inasmuch as the latter never contains any water in a state of chemical composition.

Now lava, although commonly accompanied by abundance of steam at the time of its eruption, and containing, even for several months afterwards [s], entangled within it a large quantity of aqueous vapour, holds no water in chemical combination, so that the fact stated with respect to tuff and pumice shews, that these formations have been placed under circumstances in some respects different from modern lavas.

All these varieties then of volcanic products, which Abich has classed under the general name of trachyte, approximate to granite in the circumstance of containing a trisilicate of alumina or of some corresponding base, and hence may be supposed to be more immediately derived from the latter rock, than other igneous formations are. Nevertheless in one variety of it, namely in the species distinguished by Beudant as trachytic porphyry, quartz is present, and accordingly this modification would seem to present the nearest approximation to granite, the chief difference indeed between the two being the partial substitution of glassy felspar for orthoklase, minerals of analogous constitution, though of different external characters, and with different relative proportions of the two alkalies present in them.

In trachytes properly so called there would appear

[s] See my Memoir on the Eruption of 1834, in Ph. Trans. for 1835.

to have been such an accession of alkali and of earths, that the whole of the silica entered into combination, and consequently no quartz exists in the rock.

But when we proceed to the lava-currents which have been emitted from actual volcanos, or to the analogous trap formations which are regarded as the effects of submarine eruptions, we find a still further diminution in the proportion of silica, indicated by the substitution of labradorite for orthoklase, or in other words, of one atom of felspar instead of three, coupled with the presence of hornblende or augite [t], in both which minerals the silica bears a still smaller proportion to the base with which it is combined.

In these last minerals two new elements also make their appearance, which are seldom or never present, except in small quantities, in granite or in trachyte—I mean lime and magnesia; thus evincing already a change in the nature of the igneous operations, or in the materials upon which they were exerted.

Thus the modern lavas of mount Etna have been determined by Lowë [u] to consist of an intimate mixture of labradorite and of augite, and a lava which had recently flowed from Stromboli was as-

[t] Hornblende is $\dot{R}\,\dddot{Si} + \dot{R}^3\,\dddot{Si}^2$, where $\dot{R}$ is generally lime, but sometimes protoxide of iron, or soda; and $\dot{R}^3$ is generally magnesia, but sometimes protoxide of iron. In some hornblendes the silica seems to be partially replaced by alumina. *Bonsdorff*. Augite is $\dot{R}^3\,Si^2$, where $\dot{R}$ is either lime, magnesia, protoxide of iron, or protoxide of magnesia. The silica is sometimes replaced by alumina, as is the case also in hornblende. See Rammelsberg's Dictionary of Mineralogy, Berlin 1841.

[u] Jameson's Journal, 1837.

certained by Abich to possess the same composition.

Greenstone, or dolerite, is composed of nearly the same materials, its compactness being merely the effect of the greater pressure to which it was subjected during the act of cooling.

Abich however has found it necessary to distinguish a class of formations intermediate between trachytes and greenstones, which he denominates trachyte-dolerite. To this he refers the rocks which encircle the peak of Teneriffe, those of one of the volcanos in Kamscatka, of the little cluster of islands between Lipari and Stromboli described by Hoffmann, and above all the material which constitutes the Monte della Croce, the central cone of Rocca Monfina already alluded to. Abich considers the felspar present in this rock to be oligoklase, which by reference to the table will be found to be a bisilicate, and the many green specks of augite which pervade it indicate a further change in the composition of the mass, and a nearer approach to greenstone. With this latter material, which, as we have seen, is a compound of augite with one of the species of felspar poorest in silica, the rock called basalt must not be confounded; as in it we may recognise a still further step in the elaboration of the constituents, this substance being composed of an intimate mixture of augite and magnetic iron, with a mineral of the zeolitic family. The composition of the latter is such as to imply, that it may have been formed out of labradorite with the addition of water, the presence of which in all zeolites

is the cause of that bubbling up under the blowpipe, which has occasioned them to be distinguished by that general appellation.

We perceive a similar change in the rock called clinkstone, which has been shewn by Gmelin to be an intimate mixture of glassy felspar with a zeolite.

Thus as we proceed towards the more modern groups of volcanic formations, we find new ingredients successively coming into play; first the alkalies increasing, then lime and magnesia becoming part of the constitution of the mineral mass, and lastly water entering into combination with the earthy materials.

The gradual increase of soda is likewise a remarkable circumstance, modern lavas appearing to contain a much larger quantity than the volcanic products of ancient periods, and hence various minerals being produced in which this alkali is predominant [x].

These facts may perhaps suffice to shew, that the original material out of which volcanic rocks of whatever age have been elaborated was of a granitic nature—a strong confirmation, as it appears to me, of the old opinion, that this rock stands lowest in the series of Formations, and serves as the foundation upon which the rest repose.

The same circumstances may likewise be alleged as proofs, that the igneous operations actually going on are in many respects different from those which produced the primæval granite, to which conclusion we shall also be led, by considering the differences that exist between the composition of the ancient

[x] As natrolite, nepheline, thomsonite, &c.

volcanic products of the Monte Somma, and those resulting from the operations of Vesuvius at the present day.

Thus if we go back to the period when the materials which constitute the tuff about Naples were ejected, we shall find that pumice was then one of the principal products; whereas it is now never found amongst the ejected masses at Vesuvius.

Now pumice has been shewn to be merely an altered condition of trachyte, and not to be derivable from felspars so poor in silica as labradorite, or anorthite. Moreover Mons. Dufrenoy has ascertained, that the lavas of Monte Somma are almost unattackable by acids, whilst in those of Vesuvius the proportion of the soluble to the insoluble part is in general about as four to one. The former contain a larger proportion of potass, whilst in the latter soda predominates.

It is also a well ascertained fact[y], although disputed in an English work of authority, that this volcano was formerly much more prolific in minerals, than it appears to be at present, very few at least out of the large number of species found within the range of Vesuvius existing in its

[y] For this I need not go further than the Guida de Napoli already quoted, the geological portion of which was contributed by professor Scacchi, a very accurate mineralogist, who has done a service to science, not only by the discovery of many new species at Vesuvius, but also by identifying several of those which Monticelli had created with substances previously discovered. From his enumeration of the minerals found about Vesuvius, it will be perceived that, with the exception of felspar, augite, hornblende and brieslakite, they all appear to be derived from the extinct volcano of Monte Somma.

modern lavas, whilst they abound amongst the ejected masses imbedded in the tuff of Monte Somma.

Having now endeavoured to trace the particulars in which the processes of an igneous character going on at the present day differ from those which gave rise to the rocks commonly called plutonic, I will next briefly consider, which of the commonly received theories of volcanos is most reconcilable with the phenomena which have just been pointed out.

I may remark in the first place, that there are only two modes of explaining volcanic action, which deserve a moment's attention, when viewed by the lights of modern science.

One set of philosophers, inferring from the oblate spheroidal figure of the globe, that it was once in a state of fluidity from igneous fusion, and again, presuming, from the increasing temperature observed as we descend deeper and deeper into its recesses, that it may retain enough of its heat at the present time to be preserved in a state of fusion below certain depths, propose a very simple mode of explaining the evolution of melted matter from volcanos, by attributing it to the contraction of the crust of the globe upon its fluid contents, by which a portion of the latter is from time to time expressed at the points of least resistance.

Others, considering—that all the matters ejected from a volcano contain an inflammable base united with oxygen—that the latter need not be supposed to have been present in the interior of the earth

in quantity sufficient to combine with all the principles for which it could exert an affinity—and therefore that these bases may without violence be supposed to exist in an unoxidised state at a certain distance from the surface—have proceeded to shew, that assuming such to be the fact, all the phenomena of volcanic action may be explained according to the received principles of chemistry, by the access, first of sea water, and afterwards of atmospheric air, to the interior of the globe.

For, granting that no other of the bases which enter into the composition of lava would inflame on the approach of water, the metals of the alkalies at least, which constitute sometimes as much as one tenth of the entire bulk of the ejected matter, would certainly do so, whence must result an evolution of hydrogen, and a generation of heat, sufficient to cause all the other bases present to unite with the oxygen presented to them.

But, without entering into a complete exposition of this theory, I think it must on all hands be admitted, that if its relative merits are to be decided by its capability of explaining the phenomena, it may fairly claim the preference over the rival hypothesis.

If indeed we assume, that the globe was once fluid, and take for granted, that it still retains a sufficiently high temperature to preserve its original fluidity in the interior (although the slight depth to which we have yet penetrated hardly justifies us in speaking decisively as to the state of things which may exist below a certain depth) there is even then but one phenomenon of volcanic action,

which, so far as I know, can be fairly deduced from these premises—namely the protrusion in certain localities of melted matter from the surface. For the ejection of fragments of rocks, the evolution of steam, and the disengagement of various gaseous compounds, are phenomena of which this hypothesis seems to give no account. Nor does it seem clear, why the lines of least resistance should be found almost invariably near the sea, or why indeed they should occur at all underneath the bed of the ocean, where the controlling pressure must be even greater than in the midst of our continents.

Accordingly most of those persons who profess to hold to the theory of central heat, in reality combine with it some hypothesis into which chemical considerations enter.

They explain, for instance, the evolution of steam, and of muriatic acid, by the access of salt water to the spots where this melted matter is supposed to exist, by the chemical action of which the muriatic acid is separated from its base, and the water converted into steam.

By this addition to the theory we advance, indeed, one step towards the solution of the problem; but there will still, I conceive, be a difficulty in explaining other of the connected phenomena: such, for example, as the generation of ammonia, which so often is present amongst the products of a volcano; the evolution of air usually deprived of its oxygen, which bears witness to the existence of some processes of oxidation going on underneath; and above all, the escape of inflammable gases, into which hydrogen enters as a constituent.

With regard to the first of these facts, the generation of ammonia cannot be disputed, although the amount formed by volcanic action may still remain a matter of surmise.

Those however, who, with Baron Liebig, deny, that gaseous nitrogen is capable on the surface of the earth of forming any direct combination either with oxygen, or with hydrogen, may be less inclined to condemn the hypothesis, with reference to this subject, which I have thrown out in a former publication[z], and which assumes, that the quantity so formed was once very considerable, as it traces to volcanic processes carried on in the interior of the globe all the ammonia which would be requisite for supplying the first plants with the nitrogen they must have contained; just as others have imagined all the carbon necessary for the primeval vegetation to have been derived from carbonic acid arising from the same internal source.

At least however even those who refuse to go with me up to this point, will admit, on the faith of the evidence which I have adduced, the second fact noticed, namely, the extrication of nitrogen gas, either pure, or with a small admixture of oxygen, from thermal springs in general; since amongst the whole extensive Catalogue of them[a], cited as having been personally examined by myself, in various parts, both of the Old and New World, scarcely one could be fixed upon which does

[z] Three Lectures on Agriculture, page 97.

[a] See, for those in the Old World, Report on mineral waters, Br. Associat. Reports for 1836, for those in the New, my Sketch of the Geology of N. America.

not present this phenomenon, excepting indeed a few in the island of Ischia, the origin of which is manifestly nothing more than the rain water, which had collected in internal reservoirs at a small depth beneath the surface, and had then become heated by the rock still partaking of the high temperature it had acquired by recent volcanic operations.

And with respect to the last fact mentioned, it is one so inexplicable by the mere access of water to an incandescent body, already saturated with oxygen, such as lava, that the opponents of the chemical theory have no other resource than to deny its reality.

"If inflammable gases were present," they say, "they would burn on coming into contact with the air, and hence flames would be commonly seen issuing from the orifices of an active volcano.

"But the appearances which have been taken for flames turn out to be illusory, being due merely to the reflection of the light radiated from the red hot stones ejected, and not derived from gaseous matter in a state of combustion."

Now that flames should not be of ordinary occurrence in volcanos may be explained without much difficulty.

In the caverns and fissures through which the gases evolved had to pass before they reached the circumference of the earth, and escaped from the orifice of the volcano, they must often come into contact, either with oxygen, or with oxidized bodies from which they would be able to abstract the same principle. In both these cases the hydrogen would recombine with oxygen, and return to the focus of the volcano, as water.

But supposing oxygen gas to be absent, or not

to exist in sufficient quantity to unite with all the inflammable matter evolved, the latter would in most cases be accompanied with such volumes of steam, as alone must prevent it from entering into combustion when it came into contact with the external air, for it is well known from the researches of Davy, that a certain percentage of any uninflammable gas, or vapour, prevents such bodies from taking fire.

It is therefore far more easy for the advocates of the chemical theory to account for the general *absence* of flames about the orifices of active volcanos, than for the supporters of the contrary hypothesis to explain their occasional *presence;* and that they are sometimes observable seems to be now ascertained, not only from the testimony of Sir H. Davy himself, who states that he observed at Vesuvius, during a small eruption, the existence of a real jet of flame, and that of Mons. Elie de Beaumont, who assures us of the same fact as witnessed by himself at Mount Etna, but more recently by the observations made by Professor Pilla of Pisa[b], who has given us a circumstantial account of three several occurrences of this kind in the years 1833 and 1834 at Vesuvius.

My own persuasion therefore is, that hydrogen gas, derived from the decomposition of water, most generally in combination with sulphur, is evolved in enormous quantities from all volcanos, but that a comparatively small proportion of it usually finds its

[b] See his "Discorso sopra la produzione delle fiamme nei Vulcani, &c." read at the 5th Italian Scientific Congress, held in 1843, and translated in Jameson's Journal for April, 1844.

way upwards to the surface; since if sulphurous acid be present likewise, the two gases will decompose each other, so that only the excess of the one most abundant will remain, and if it meet with oxygen in its progress upwards, it will combine with this principle, and water will consequently result.

Nevertheless I hold, that the sulphuretted hydrogen which impregnates the mineral waters, in various ignigenous, and even in certain primary districts, is derived from some volcanic *focus;* I am inclined to believe, that the beds of sulphur met with in various parts of the world, where igneous agents have been at work, as in Sicily, owe their origin to the decomposition of sulphuretted hydrogen disengaged from the same source; and conclude therefore, that it is not unfrequently evolved from the orifices of volcanos, although for the most part prevented from inflaming by the large intermixture of aqueous vapour which usually accompanies it.

But without entering at this advanced period of the evening into a general discussion of the question, I will merely point out to you, how completely this theory squares with the manner, in which I have shewn the several products of volcanic action to be successively produced from the constituents of granite.

We have seen that these changes of form and structure have been produced by the addition of lime, magnesia, potass, soda, oxide of iron, water, &c. to the mica, quartz, and felspar, present in the original material.

Now it is evident that, besides the water, only one of these bodies, namely the soda, could have been

supplied in sufficient quantities by the sea; the access of which to the focus of the volcano there are so many reasons for supposing an immediately exciting cause of the operations we witness. Is it not therefore reasonable to suppose the other constituents to have existed in their unoxidised state below, and thus to have contributed by their oxidation to the high temperature, as well as to the generation of those inflammable gases which arise during the process?

Again, it is not an unimportant circumstance to remark, that the iron found in lavas and in trap is usually magnetic, or partly in the state of protoxide; whilst in granite it exists wholly as a peroxide. May not the partial change from peroxide to protoxide be brought about by the action of the hydrogen disengaged, and does not the presence of protoxide of iron sufficiently explain, why none of the more oxidisable metals are ever found in lava, except saturated with oxygen[c]?

These considerations, if they do not persuade you of the truth of my hypothesis, may at least plead my excuse for having ventured to maintain it, even though it be one which seems to have been repudiated by Sir H. Davy, and which a geologist of reputation once, I think, stigmatized, by designating it as *smelling of the laboratory*.

[c] This is alleged by Dr. John Davy, as a circumstance which operated on his brother's mind in inducing him towards the close of his life to abandon the chemical theory. I cannot, however, agree with him in thinking, that the presence of potassium, sodium, or even calcium, amongst the ejections of a volcano, ought to be expected according to the conditions of this hypothesis.

With respect to the former ground of discouragement, I have already given my reasons for not regarding it as absolutely fatal; and with respect to the latter, as we all, I hope, in the 19th century, are aware, that modern Chemistry is not confined within the limits of the apothecary's shop, I consider it the highest testimony in favour of any geological theory, to be able to say of it, that it has been submitted to the severe ordeal of chemical examination, and has not been found wanting[d].

In conclusion then, I will remark, that my three visits to Naples have afforded me the materials for laying before you, on this and on two former occasions, a sketch of the phenomena presented by the three great volcanic systems which exist within the compass of that territory, and thereby, as it so happens, exhibiting a picture of three different phases or conditions of igneous action, exemplified in the three localities which I have successively brought to your notice, namely in the country im-

[d] On this subject however it behoves me to speak with some diffidence, when I see the contrary maintained by so eminent a chemist as Professor Bischof of Bonn. All I can say is, that the objections he had originally put forth to this hypothesis have been answered, in a manner which to my mind at least appeared satisfactory, in Jameson's Journal for April, 1839. The Professor however having, in his memoir on the Natural History of Volcanos and Earthquakes published in the very same number of that Journal, reiterated some of these, and added a few other remarks, I will refer to the Appendix for a statement of the grounds on which I conceive my original views to remain still unshaken; although it may be suggested, that the Professor's remarks referred to must, from their date, have been written, before he could have seen my reply to his original memoir. *See Appendix.*

mediately round about Vesuvius, at Mount Vultur, and at Rocca Monfina.

The first of these localities exhibits no doubt the most striking, the most varied, and perhaps altogether the most instructive series of phenomena; inasmuch as it has constituted a permanent vent for the products of the chemical actions going on in the interior of the globe, ever since the cessation of those kindred phenomena which we read of as having been displayed formerly within the compass of the Phlegrean Fields, and which had rendered that district an object of terror to the early Greeks, invested their inhabitants the Cimmerians with a kind of vague and mysterious awe, and led the poets to place the entrance to the infernal regions amongst their caves and forests.

But our knowledge of the subject would be incomplete, if we did not extend our observation to such mountains as Mount Vultur and Rocca Monfina.

In the former of these we perceive a volcano which was extinguished, as it were, by the very throes that accompanied its birth; for the volcanic energy which heaved up the materials of which the mountain is composed, and produced a crater in the midst of it, seems to have been expended in that very effort, and never afterwards to have exhibited any signs of vitality, either by emitting streams of lava or ejections of scoriæ.

It is an example therefore of a simple crater of elevation, not converted, like Vesuvius, into a permanent volcano, by having become the vent for

successive eruptions of igneous matter at any period subsequent to its formation.

In Rocca Monfina on the other hand, we are enabled to observe the precise agents which Nature calls into operation for the purpose of elevating volcanic hills in general, whether the latter be destined to remain merely as monuments of what she has accomplished at a distant period of time, or to serve likewise in after-ages as chimneys for her subterranean laboratory, the trachytic rock of Monte della Croce being here seen actually protruding through the crater, in the centre of the mountain, which it has no doubt contributed to upraise.

Rocca Monfina also appears to have given off one, if not two streams of lava, but the volcanic processes would seem to have soon been transferred to some other quarter, as from a period long antecedent to historical records, it has sunk into complete inactivity.

Thus we observe in these three mountains three successive developments of volcanic activity, evinced,

1st, in the elevation of an entire mountain,

2nd, in this elevation being accompanied by the protrusion of a trachytic rock through its centre,

3rdly, in the elevation of a mountain being followed, after a long interval of apparent tranquillity, by the establishment of a permanent vent, through which lavas, fragments of rocks, and elastic vapours, continue from time to time to be discharged.

All these however are derived from subaëreal volcanos, having been formed on dry land, under no

greater pressure than that of the atmosphere, and are consequently of later date than the beds of tuff which are spread on all sides around them, the latter being products of the action of volcanos which existed when the country was yet under the bed of the Mediterranean, and consequently being modified in their characters and structure, by admixture with the sea water in which they appear to have been deposited.

APPENDIX I.

Rammelsberg's Classification

Definition of the Classes.		Symbols representing the Classes.	Subclasses.
1st. Class	Silica alone	$\overset{\cdots}{\mathrm{Si}}$	without water with water
2nd. —	Silica united with a single Base, having 1 Atom of Oxygen	$\overset{\cdots}{\mathrm{Si}}\ \overset{\cdot}{\mathrm{R}}$	without water with water
3rd. —	Silica united with a single Base, having $1\frac{1}{2}$ Atoms of Oxygen ..	$\overset{\cdots}{\mathrm{Si}}\ \overset{\cdots}{\underline{\mathrm{R}}}$	without water with water
4th. —	Silica united with several Bases, all with 1 Atom of Oxygen....	$\overset{\cdots}{\mathrm{Si}}\ \overset{\cdot}{\mathrm{R}} + \overset{\cdots}{\mathrm{Si}}\ \overset{\cdot}{\mathrm{R}}$	without water with water
5th. —	Silica united with several Bases, all with $1\frac{1}{2}$ Atoms of Oxygen ..	$\overset{\cdots}{\mathrm{Si}}\ \overset{\cdots}{\underline{\mathrm{R}}} + \overset{\cdots}{\mathrm{Si}}\ \overset{\cdots}{\underline{\mathrm{R}}}$	without water with water
*6th. —	Silica united with several Bases, both with 1 and $1\frac{1}{2}$ Atoms of Oxygen.....	$\overset{\cdots}{\mathrm{Si}}\ \overset{\cdot}{\mathrm{R}} + \overset{\cdots}{\mathrm{Si}}\ \overset{\cdots}{\underline{\mathrm{R}}}$	without water without water with water with water
7th. —	Silicates united with Aluminates	$\overset{\cdots}{\mathrm{Si}}\ \overset{\cdot}{\mathrm{R}} + \overset{\cdots}{\underline{\mathrm{Al}}}\ \overset{\cdot}{\mathrm{R}}$	.....
8th. —	Silicates united with other salts ..	.....	with Sulphates with Fluorides with Borates

* As the minerals comprehended under this Class are numerous, the Subclasses are again subdivided according to the proportion which the Silica in each of the two binary compounds of which the mineral consists, bears to the bases with which it is united.

Thus the Subclass without water is divided as follows :

1st. Division. Both Silicates neutral—example Albite.
2nd. ——— One Silicate neutral ; with one $\frac{2}{3}$—example Spodumene.
3rd. ——— One Silicate neutral ; with one $\frac{1}{3}$—example Ryakolite.

o page 27.

f Siliceous Minerals.

Examples of the Class and Subclass.	Symbol of the Mineral.
Quartz	$\overset{\cdots}{Si}$
Opal	$\overset{\cdots}{Si} + \overset{\cdot}{H}$
Tablespar	$\overset{\cdot}{Ca^3}\ \overset{\cdots}{Si^2}$
Meerschaum	$\overset{\cdot}{Mg}\ \overset{\cdots}{Si} + \overset{\cdot}{H}$
Cyanite	$\underline{\overset{\cdots}{Al}}^2\ \overset{\cdots}{Si}$
Kaolin	$\underline{\overset{\cdots}{Al}}^3\ \overset{\cdots}{Si}^4 + 6\overset{\cdot}{H}$
Augite	$\overset{\cdot}{R^3}$ (viz. $\overset{\cdot}{Ca}$; $\overset{\cdot}{Mg}$; $\overset{\cdot}{Fe}$; $\overset{\cdot}{Mn}$) $\overset{\cdots}{Si^2}$
Apophyllite	$\overset{\cdot}{R^3}\ \overset{\cdots}{Si}^4 + 6\overset{\cdot}{H}$
Beryl	$\overset{\cdots}{Be}\ \overset{\cdots}{Si}^4 + 2\underline{\overset{\cdots}{Al}}\ \overset{\cdots}{Si^2}$
Bole	$\overset{\cdots}{R^2}$ ($\underline{\overset{\cdots}{Al}}$; $\underline{\overset{\cdots}{Fe}}$) $\overset{\cdots}{Si}^3 + 9\overset{\cdot}{H}$
Felspar	$\overset{\cdot}{R}$ ($\overset{\cdot}{K}$; $\overset{\cdot}{Na}$) $\overset{\cdots}{Si} + \underline{\overset{\cdots}{Al}}\ \overset{\cdots}{Si^2}$
Garnet	$\overset{\cdot}{R^3}$ ($\overset{\cdot}{Ca}$; $\overset{\cdot}{Mg}$; $\overset{\cdot}{Fe}$; $\overset{\cdot}{Mn}$) $\overset{\cdots}{Si} + \underline{\overset{\cdots}{R}}$ ($\underline{\overset{\cdots}{Al}}$; $\underline{\overset{\cdots}{Fe}}$; $\underline{\overset{\cdots}{Mn}}$) $\overset{\cdots}{Si}$
Mesotype	$\overset{\cdot}{R}$ ($\overset{\cdot}{Ca}$; $\overset{\cdot}{Na}$) $\overset{\cdots}{Si} + \underline{\overset{\cdots}{Al}}\ \overset{\cdots}{Si} + 3\overset{\cdot}{H}$
Cross-Stone	$2\overset{\cdot}{R^3}$ ($\overset{\cdot}{Ba}$; $\overset{\cdot}{K}$) $\overset{\cdots}{Si}^4 + 7\underline{\overset{\cdots}{Al}}\ \overset{\cdots}{Si^2} + 36\overset{\cdot}{H}$
Grenatite	$3\underline{\overset{\cdots}{Al}}\ \overset{\cdots}{Si} + \overset{\cdot}{Fe}^3\ \overset{\cdots}{Al}^2$
Hauyne	$\overset{\cdot}{Ca}^3\ \overset{\cdots}{Si}^2 + 3\underline{\overset{\cdots}{Al}}\ \overset{\cdots}{Si} + 2\overset{\cdot}{K}\ \overset{\cdots}{S}$
Lepidolite	$4\underline{\overset{\cdots}{Al}}\ \overset{\cdots}{Si}^2 + \overset{\cdot}{K}\ \overset{\cdots}{Fl}^2 + 2\overset{\cdot}{Li}\ \overset{\cdots}{Fl}$
Tourmaline	$\overset{\cdot}{R}\ \overset{\cdots}{B} + \underline{\overset{\cdots}{Al}}\ \overset{\cdots}{Si}$

th. Division. Both Silicates $\frac{2}{3}$—example Leucite.
th. ——— One Silicate $\frac{2}{3}$; one $\frac{1}{3}$—example Scapolite.
th. ——— Both Silicates $\frac{1}{3}$—example Epidote.
th. ——— One Silicate $\frac{1}{3}$; one $\frac{1}{6}$—example Lievrite.
th. ——— One Silicate $\frac{1}{2}$; one $\frac{1}{3}$—example Nepheline.
th. ——— Both Silicates $\frac{4}{3}$—example Petalite.
oth. ——— One Silicate $\frac{4}{3}$; one $\frac{1}{3}$—example Murchisonite.
The same is the case with the Subclass containing water.

APPENDIX II. to page 34.

Abich's Observations on the formation of Obsidian and Pumice.

The mode in which pumice and obsidian have been formed can only be cleared up, through a more exact scrutiny into the nature of the volatile materials which both these bodies in greater or less quantity contain. Humboldt and others have remarked upon the swelling out which certain obsidians undergo at a white heat, and have found a great difference in this respect to exist between specimens taken from different localities.—Abich has further ascertained, that the poorer in silica, and the richer in alkaline bases obsidian is, the more in short its composition approaches to clinkstone, the more readily it may be made to pass by heat into the condition of pumice.

It being admitted, that the immediate cause of the change is the extrication of some volatile principle, the nature of this latter becomes the next subject for inquiry.

Abich found, that in order that the mineral should swell out into a porous mass, it must be submitted to heat in lumps; for if it be in powder, it does not undergo any such tumefaction by exposure to a high temperature, but only changes to a dark red or brown colour; losing during the process twice as much weight as the same had done in lumps; from which it would appear, that only a portion of the volatile ingredients which escape from the powder is in the former case disengaged.

By comparing the analysis of obsidians with that of pumices obtained from the same locality, it would appear, that although the sum of the alkaline bases is in both very nearly the same, yet that there is more potass in obsidian, more soda in pumice, the increase in the one alkali corresponding with the deficiency in the other.

This might lead one to conjecture, that during the formation of pumice a certain amount of potass was dissipated, and a proportionate quantity of soda introduced

from without, and that from the disengagement of the former, the cellular condition of the mineral might have resulted.

It will be readily supposed, that both obsidians and pumices are often very widely different one from the other in their constitution, and that of the latter the darker and more cellular varieties may arise from a predominance of earthy and alkaline bases, the white and silky looking kind from a larger amount of silica.

When felspathic rocks, rich in alkali, pass into a state of fusion in the presence of some earthy base, the latter displaces a portion of the alkali, and thus causes the mass to swell out.

It is worthy of remark, that chlorine and water are present in all pumices and obsidians, and that from many, certain inflammable gases are also disengaged. This latter fact indeed has led some chemists to imagine, that the cellularity of pumice may have been caused by the disengagement of carburetted hydrogen, derived from the bitumen which Knox discovered in certain obsidians; but this cannot be the case, as the presence of bitumen is an exception rather than the rule. It is more probable, that the formation of pumice is connected with the disengagement of chlorine, derived from sea salt, which may be decomposed by the heat, its soda being seized upon by the mineral, and entering, as before explained, into its composition.——A portion of this chlorine however adheres most tenaciously to the mineral mass, as is proved by the fusion of pumice into glass, as even then it retains a portion of this volatile ingredient. With respect to obsidian, Abich conceives, that the greater and more continued the pressure to which the melted material has been subjected may be, the greater tendency will be shewn by the mass, both to assume a stony rather than a vitreous texture, and to form definite and distinct minerals, rather than one homogeneous amorphous compound.. Hence from the same material lithoide lavas may be produced under pressure, vitreous ones in the open air.

APPENDIX III. to page 46.

On the Chemical Theory of Volcanos.

Professor Bischof justly observes, "that the close connexion between volcanos and hot springs would lead us to refer both to the same cause." "But," he continues, "thermal springs are too universally distributed to be accounted for by chemical processes going on in the interior of the globe. They seem to occur everywhere where the water rises from a great depth. They must therefore be attributed merely to the high temperature which generally pervades the interior of the globe."

To this I would reply, that no one questions that the high temperature of a spring is acquired immediately from that of the rock from whence it proceeds, or supposes the rock, when it lies at a distance from any volcano, to derive its heat from chemical processes taking place within itself. From a mineral mass so circumstanced, as well as from a water simply thermal, we can collect nothing which should lead us to give the preference to either theory; it is only from analogy, that the heat either of the one or of the other can be explained. But more commonly hot springs, like volcanic eruptions, are accompanied with other products, which seem to imply the existence of chemical action—hot springs, for instance, with carbonic acid, sulphuretted hydrogen, and azote—ejections of lava, with steam, muriatic acid, sulphuretted hydrogen, and ammonia. The carbonic acid indeed might be evolved from limestone by the mere access of heat, but I cannot agree with Professor Bischof in attributing the sulphuretted hydrogen to a decomposition of sulphates by organic matter. Sulphuric salts do not occur in the majority of these springs, and the small quantity of baregine there existing (the only organic matter which is present) appears to be generated after the water has

reached the surface. Neither can the almost constant escape of azotic gas be accounted for, without supposing some process of oxygenation to be going on in the interior.

Now these springs usually make their appearance, where other evidence of volcanic action is exhibited, in the dislocation and elevation of the surrounding strata, and the latter phenomena occur so extensively over the earth's surface, that volcanic operations, if assumed to be their cause, may have been widely enough distributed to produce a general increase of temperature throughout that zone in the interior of the globe in which they are carried on. What may be the condition of the earth lower than this we surely have no data for ascertaining, for it is evident, that if this supposed zone lie below the level which mining operations have ever reached, it would itself elevate the temperature of all those portions of the earth's crust of which we have any actual cognizance.

I am however unwilling to dogmatise, either with respect to the general cause of the internal heat of the globe, or the limits to which this heat may be confined.

All I have ever sought to prove is, that, be the existence of a central heat ever so well established, its assumption does not advance us towards the explanation of the phenomena, either of volcanos, or of thermal springs in general, and that a process of oxidation is going on, often with intense energy, in the interior of the globe, of a different nature from that usually occurring on the surface, as being attended with an evolution of hydrogen gas, a phenomenon which can be most readily explained by the decomposition of water, through the action of the metals of the earths and alkalies upon that liquid.

I would finally remark, that Professor Bischof will find his objection to the supposed existence of these bases in the interior of the globe arising from their low specific gravity, answered by anticipation in my Reply to his former Paper, as I have there shewn, that the specific gravity of one hundred parts of the metallic principles

present in a mass of ordinary lava, would be quite as considerable as that of the same amount of these same bodies united with oxygen, so that the difficulty, be it small or great, which attends the fact of the high specific gravity of the globe, as compared with that of the materials composing its surface, is the same to those who reject my hypothesis, as to those who embrace it.

Lest however it should be imagined, that I have attached an undue weight to this theory, or have done more than to advocate it as the most plausible account that can at present be given of the facts before us, I will in conclusion extract the remarks which I made nearly ten years ago, in my Report on Mineral and Thermal Springs, undertaken at the request of the British Association.

"We ought carefully to distinguish between that which appears to be a direct inference from observed facts, and what at most can advance no higher claim than that of being a plausible conjecture. The general occurrence of volcanos in the neighbourhood of the sea, and the constant disengagement of aqueous vapour and of sea salt from their interior, are facts, which establish in my mind a conviction, that water finds its way to the seat of the igneous operations, almost as complete, as if I were myself an eyewitness of another Phlegethon discharging itself into the bowels of the earth, in every volcanic district, as in the solitary case of Cephalonia.

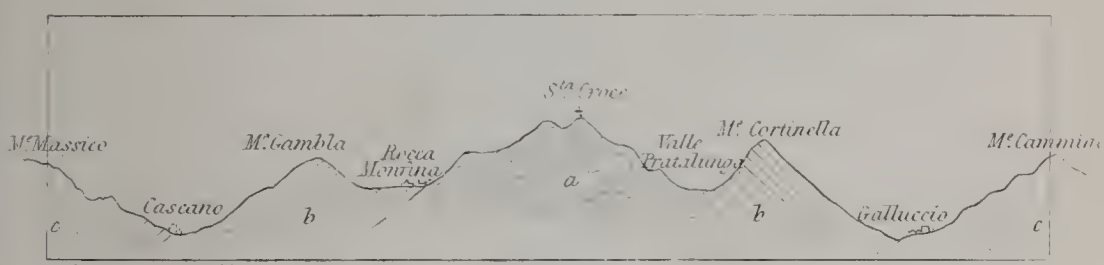
Nor is the access of atmospheric air to volcanos more questionable than that of water; so that the appearance of hydrogen united with sulphur, and of nitrogen, either alone or combined with hydrogen, at the mouth of the volcano, seems a direct proof, that oxygen has been abstracted by some process or other from both.

Having satisfied our minds with regard to the fact of internal oxidation, we naturally turn to consider, what principles can have existed in the interior of the earth, capable of abstracting oxygen from water as well as from

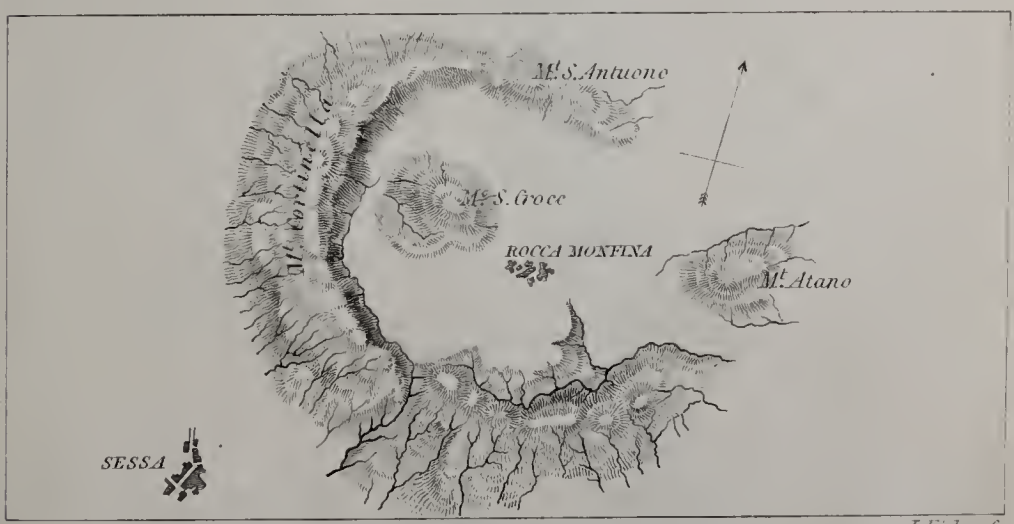
air; and this leads us to speculate on the bases of the earths and alkalies as having caused it. But in ascribing the phenomena to the oxidation of these bodies, we ought not to lose sight of the Baconian maxim, that in every well established theory, the cause assigned should be, not only competent to explain the phenomena, but also known to have a real existence, which latter circumstance cannot of course be affirmed of the alkaline and earthy metalloids as occurring in the interior of the earth."

Vesuvius, or Somma, according to Strabo.

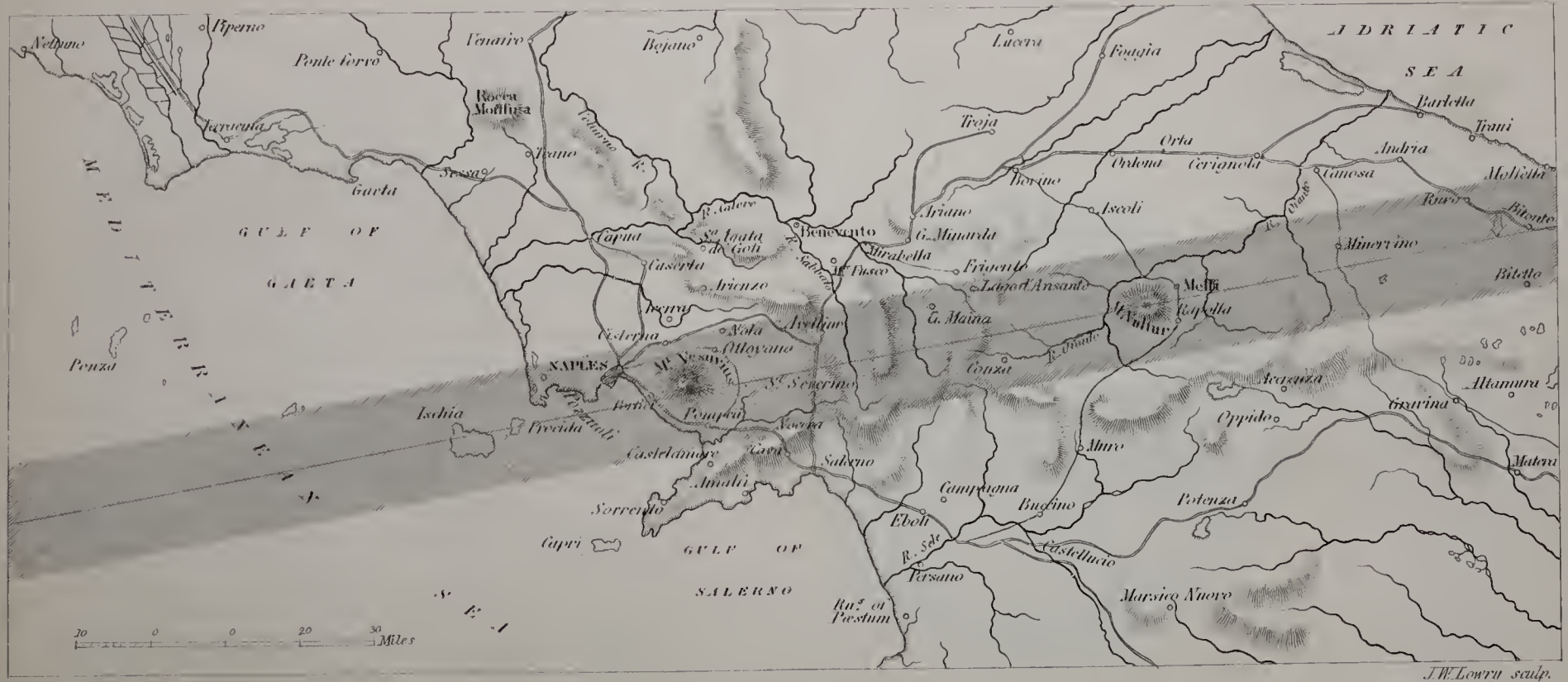
Somma and Vesuvius after the time of Pliny.



Section of Rocca Monfina.



Ground Plan of Rocca Monfina.



J.W. Lowry sculp.

MAP OF A PORTION OF THE KINGDOM OF NAPLES.

ON

THE AMPHITHEATRE

AT

POLA

IN

ISTRIA.

BY

TRAVERS TWISS, B.C.L

FELLOW OF UNIVERSITY COLLEGE.

OXFORD,

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ON THE

AMPHITHEATRE AT POLA

IN

ISTRIA.

READ TO THE ASHMOLEAN SOCIETY, MARCH 4, 1836.

THE town of Pola, where the amphitheatre, which is the subject of the present memoir, still arrests the admiration of the traveller, is situated almost at the extreme southern point of Istria, about sixteen German miles distant from Trieste. The bay, whose waters bathe the walls of the town, opens to the sea towards the west, but the islands of Brioni, which lie immediately in the entrance, give it the appearance of an inland lake. The amphitheatre is situated without the town, being built on the side of a hill gently sloping towards the bay, which approaches so near its walls, that the figure of the building is reflected on the surface of the water. It well deserves the panegyrics of Stuart and of Allason, who pronounce it one of the "most striking, beautiful, and perfect monuments of antiquity." Its exterior circuit is nearly entire, but the interior is so utterly destroyed, that Maffei mistook it for a theatre, and Lipsius describes it in these words: *At interiora omnia membra, subsellia, aditus, gra-*

dus, podia e ligno fuisse certum est et pro tempore construi potuisse, destruique [a].

The striking effect produced by this ruin on persons who have already visited the other remains of Roman amphitheatres, is perhaps to be attributed to this circumstance, that we have here no heavy unharmonious mass of ruins in the interior, but the exterior stands forth unincumbered in bold relief against the sky. There is also a peculiarity in the whiteness of the Istrian stone, which even extorted admiration from the envious Maffei. Istria, as is well known, was the quarry whence the proud palaces of Venice were reared, and the stone from this neighbourhood appears to have been of the very best quality. Its hardness has defied the action of the weather; its whiteness almost rivals the polished marble of Carrara, and when struck, it rings like the volcanic tufa, of which many of the buildings at Pompeii are constructed.

It is not the hand of time alone that has spoiled these magnificent structures. Wanton spoliation, or the necessary occupation of them as fortresses in war, has chiefly wrought their destruction. The Italian amphitheatres have in general suffered from both these causes, the French from the former only. Pola likewise has fortunately, to all appearances, been only exposed to the ravages of peace [b], and its

[a] The same idea prevailed with regard to the celebrated theatre at Taormina in Sicily, but recent excavations there have brought to light some stone seats.

[b] It was proposed by a Venetian engineer in the 16th century that the amphitheatre should be blown up: the inhabitants however of Pola had recourse to the Venetian senator Gabriel Emo, by whose intervention it was saved from such a melancholy fate.

interior, as more vulnerable, has totally fallen a prey to the spoilers. Maffei mentions a curious manuscript, of the date of 1303, A. D., in which it is stated of the Patriarch of Aquileia, *In civitate Polæ habet duo antiqua Palatia, scilicet Jadrum et Harenam, et Palatium unum in platea civitatis et quasdam alias domos. Et quicunque accipit aliquem lapidem de dictis Palatiis Jadri et Harenæ, pro quolibet lapide quem accipit, solvit Domino Patriarchæ Byzantios centum*[c]. *Jadrum* is probably a corruption of *Theatrum*, as there was originally a theatre, as described by Serlio, on a hill without the town, which was destroyed by the Venetians, and its site occupied by a fort. In *harenam* we clearly trace the Latin word *arenam*. In a similar manner the ruins of amphitheatres in France are generally known by the term *Les Arènes*, whilst those at Bourdeaux are dignified by the title of *Le Palais Galiene*[d]. I merely mention this latter fact to shew that the writer of this manuscript was not singular in dignifying the amphitheatre at Pola with the title of *palace*.

The exterior of this building is rusticated, similarly to the amphitheatres of Verona and Nismes. As to the order of architecture to which it belongs, there has been much dispute. Palladio has pronounced the architecture both at Pola and Verona to be Tuscan, whilst Serlio and Bastiano of Bologna call it Doric. Nor is this a singular instance of the

[c] These were, probably, Byzantii albi (denarii), a coin which is frequently mentioned in the chartularies of monasteries. Vide Du Cange; article, *Byzantius*.

[d] There is a full account of this in vol. XII. Histoire de l'Académie des Inscriptions.

difference of opinion between professional judges on these subjects; for Nismes is said by Daviler to be Tuscan, and by others Doric, and the amphitheatre at Capua, which is called Doric by San Felice, and Tuscan by Mazocchio, is said by others to have combined the four orders which are found in the Coliseum. Unfortunately, there is no canon of Tuscan architecture remaining: whilst, according to Maffei, the Doric order is studied to the best advantage in the theatre of Marcellus [e], the Ionic in the temple of Fortuna Virilis, the Corinthian in the pantheon of Agrippa, and the Composite in the arch of Titus, the only specimen of Tuscan is found in the column of Trajan. Yet this, according to Forsyth, has a Tuscan base and capital, a Doric shaft, and a pedestal with Corinthian mouldings, whilst the column of Marcus Aurelius repeats the same mixture. The difficulty of distinguishing the Doric from the Tuscan order in Roman edifices arises in some degree from this circumstance, that the Roman Doric had its proportions quite different from the Grecian; for, as Forsyth observes, "in Roman temples, columns were a mere decoration, or at most supported the pediment above: in the Grecian, they formed an integral part of the edifice, not engaged in the wall, but rather the wall itself." Thus at Rome the ancient Doric column is about $7\frac{1}{2}$ diameters in height; at Athens the greatest height is but 6; at Pæstum $4\frac{1}{2}$; at Corinth only 4. The total disappearance of the Tuscan is to be attributed to its own rules. The Tuscan edifices, being aræos-

[e] The lower tier of columns in this theatre is alluded to, as the upper is of the Ionic order.

tyle, had their intercolumniations so wide, that wood became necessary to form the architrave. Vitruvius [f], aware of the perishable nature of this material, gives particular directions as to the manner in which the beams should be laid: *Cum enim inter se tangunt, et non spiramentum et perflatum venti recipiunt, concalefaciuntur, et celeriter putrescunt.* I am inclined to acquiesce in the judgment of Palladio, and to pronounce the order of architecture at Pola, as well as at Nismes and Verona, to be Tuscan.

The elevation consists of two orders of Tuscan pilasters, one above the other, the lower being placed upon pedestals on the side sloping towards the sea. The whole circumference is divided into seventy-two arches; the height into three stories, and by its particular construction, the uppermost story being an Attic with flat windows, displays an uncommon lightness and elegance of effect. There is a peculiarity about this building, which is not observed in any of the Italian or French amphitheatres. If we suppose the figure to be an oval, whose greater axis lies nearly north and south, at the intermediate distances in the outer circumference between the four cardinal points, there are four buildings, like towers, forming part of the circumference, which Serlio calls *contrafforti*, as if their purpose had merely been to strengthen and support the building. A more accurate examination of them has determined that they were staircases, so contrived that there might be two flights of stairs disposed in such a

[f] Vitruvius, De Architect. lib. iv. c. 7. The intercolumniations were called *aræostyle* when the interval between the columns was greater than three diameters.

manner, that those who ascended by the one should not meet those who were descending by the other: there was room on each flight for two persons abreast. What was the precise object of these staircases is perhaps difficult to be determined. Some think that the Velarii ascended by them to arrange the awning, according as any sudden call for it should be made: others, that they merely served as *vomitoria* for the upper circles; whilst others again may be disposed to consider them as staircases which were reserved for the women to ascend by to their seats in the upper part of the building. Suetonius [g] mentions a decree of Augustus, which may serve to illustrate this latter conjecture, as females, who had hitherto mixed at large with the rest of the company, were prohibited by it from occupying any seats but those in the uppermost circles. The seats for the women, in accordance with this decree, may still be observed in the amphitheatre at Pompeii. These private staircases would be the more necessary, if females were altogether prohibited, in the same manner as at Rome by another decree of Augustus, from being present at the contests of the Athletæ, and were therefore often not allowed to occupy their seats at the commencement of the day's amusement.

It had long been supposed that the interior of this amphitheatre had been entirely of wood, the exterior being so perfect, whilst not a vestige apparently remained of the interior. When, however, Istria was occupied by the French in 1810, some excavations were commenced in the arena by the direc-

[g] Sueton. Aug. c. 44. Calpurnius Eclog. vii. 27.

tions of the duke of Ragusa, and as some important fragments were at once discovered, they were not discontinued on the subsequent cession of the country to the Austrians. The result was, that the plan of the arena and the podium was brought to light, and thus Maffei's absurd supposition, that it was a circular theatre, was completely overthrown. This author, being extremely puzzled to account for the four turrets, or staircases, assumes that two of them were on the stage side of his supposed theatre, and that the actors spoke from them in comedies, as from the windows of private houses, and that the other two were merely for the sake of preserving the uniformity of the building. This author may be dismissed at once with this observation, that the *Amor Patriæ*, condemned in Italy to circulate in such narrow spheres, had completely blinded his judgment, as his main object was to maintain the claim of his native town Verona to the possession of the only stone amphitheatre in the north of Italy.

Along the major axis of the arena there appears to have been a covered passage beneath, the roof of which was supported by pillars of the Composite order. It may either have been only for the purpose of affording a communication without crossing the arena, or have been connected with the dens of prisoners and wild beasts, as in the Coliseum and at Capua. A canal of about two feet in breadth, encircles the arena. This may have served merely for a drain, as there is a broad channel on the north-east which enters the arena from above, and communicates with this canal, and another on the south-west descending towards the sea; or it may have been a miniature Euripus, on the supposition that

wild beasts were hunted here. The height of the podium [h] is only five feet, about the same with that of Verona. Stancovich argues from comparing this with the height of the podium of the Coliseum [i] (15 feet), that wild beasts were not hunted here, or at Verona. Unfortunately, however, for his hypothesis, there is still extant a letter from the younger Pliny [k] to Maximus, whom he is complimenting for having exhibited a gladiatorial show to the good people of Verona; where he says, *Vellem Africanæ, quas coemeras plurimas, ad præfinitum diem occurrissent, sed licet cessaverint illæ, tempestate detentæ, tu tamen meruisti ut acceptum tibi fieret, quod quo minus exhiberes, non per te stetit.* The animals, which are here called *Africanæ*, were panthers, which were highly prized for such exhibitions [l]. The elder Pliny [m] states, that these animals were first introduced to the Romans by Scaurus, in his ædileship, who exhibited 150 of them at once; and that there was a special law, allowing them to be imported into Italy for exhibition at the games. This allusion of Pliny to the fact, that it was in contemplation to exhibit these panthers at Verona, overthrows the argument of Stancovich with regard to the lowness of the podium being decisive evidence that wild beasts were not hunted either at Pola or

[h] The podium is properly the projecting part of the wall that encircles the arena, but it is here used for the whole wall.

[i] According to Carli, that of Nismes was twelve feet high.

[k] Lib. vi. Ep. 24.

[l] "Pantheræ Africanæ, tantæ vivacitatis, ut exsectis visceribus, diu et acriter pugnent." See likewise the Ancyran Monument. Tac. Oberlin. iv. p. 845.

[m] Lib. viii. c. 16.

Verona. Perhaps a podium, five feet in height, surmounted with a strong balustrade, and an Euripus, two feet in breadth, so as to balk the animal in his spring, might be a sufficient safeguard to the spectators in the lower cavea against these comparatively small animals. At Rome, on the other hand, the podium was calculated to protect the spectators, not only against the ferocity and the courage of the tiger and the lion, but likewise against the immense bulk of the rhinoceros and the elephant.

The chief peculiarity of this amphitheatre is in the seats. Two or three fragments had already been discovered, when in the course of the excavations in 1810 a splendid seat was brought to light in the most perfect preservation, having certain lines, letters, and numbers marked upon it. Since that time not less than forty-two seats have been dug out of the ruins, some with letters upon them, others plain, and some with intermediate steps, where the ascent had been from one tier to another. The large seat above-mentioned has its upper surface divided into compartments by lines at the distance of 13 Venetian inches, or, as I ascertained by actual measurement[n], $14\frac{1}{2}$ English[o]. This space of $14\frac{1}{2}$ English inches, although not excessive, was found by us on experiment to be a fair allowance, and from the allusions in Latin authors we

[n] The author of this memoir visited Pola in the autumn of 1834.

[o] On this large stone five of these compartments may be observed: at one extremity there is a small space of five inches, and at the other one of nine, which probably was completed on the next seat. (Vide Plate.)

are led to suppose that the audience was packed tolerably close, as in the "cavea[p]" of modern theatres. To this Ovid[q] alludes in the following lines:

Quid frustra refugis? cogit nos *linea* jungi;
Hac in lege loci commoda circus habet.

The same space we found uniformly prevailed in all the seats. One of these seats is remarkable from a double row of lines. The first space marked off was only 11 Venetian inches: the mason did not perceive his error at first, and had drawn the two next lines at the proper distance of 13 inches, when he found himself obliged to commence again; and we have thus a series of pairs of lines two inches apart.

With regard to the breadth of the seats, by which is meant the space from the front to the back, the measure is not uniform: that however of the large seat above alluded to, and of eighteen others, is about 24 Venetian inches, equivalent to about $27\frac{1}{2}$ English. The block of stone, however, did not terminate here, but was continued further backward, being lowered about half an inch, aud thus forming a groove for the next succeeding upper stone to fit into. That the breadth of the seats in the Circus was not very great, we may also infer from Ovid[r]:

Tu quoque qui spectas post nos, tua contrahe crura,
Si pudor est, rigido ne preme terga genu.

The breadth of the remaining seats varies from 24 to 33 Venetian inches.

[p] See Appendix.

[q] Ovid, Amor. l. iii. El. 2.: also Ars Am. l. i. v. 139.

[r] Am. iii. l. 23: also, Am. i. l. 159.

There is likewise some variation in the heights of the seats. But of the whole number of forty-three we have the large perfect one and eighteen others of the same height, $13\frac{1}{2}$ Venetian inches; the rest vary from $13\frac{1}{2}$ to 24 Venetian inches. It would appear from this that the minimum height is $13\frac{1}{2}$ inches, and if we allow half an inch for the stone to fit into the groove of the seat below, the minimum height of a seat was 13 Venetian inches, and the minimum breadth, as before mentioned, 24 Venetian inches. If, now, we refer to the directions given by Vitruvius [s], for the construction of the seats in theatres, we find the following words: *Gradus spectaculorum ubi subsellia componantur, ne minus alti sint palmopede, ne plus pede et digitis sex. Latitudines eorum ne plus pedes duo semis, ne minus pedes duo constituantur.*

The measure of the Roman foot has long been a *vexata quæstio.* If we adopt the calculations in the *Metrologie* of De Romé de l'Isle, there were three varieties of feet in principal use amongst the Romans. The Geometrical foot of 16 digits, the 600dth part of the nautical stadium [t], is supposed to have been chiefly employed by them in nautical and astronomical calculations. The Capitoline foot of $16\frac{3}{3}\frac{1}{2}$ digits, engraved by Luca Petto in the Capitol, and verified by Fabretti from a careful comparison of it with three ancient iron foot-measures dug up amidst some ruins of great antiquity, is what is more especially called the Roman foot, and is sup-

[s] De Architect. v. c. 6.

[t] This stadium was the 400,000dth part of a degree, being the same as the Persian stadium, which Herodotus makes use of.

posed to have been the foot in common use, by which the Roman roads were measured. The Philæterian, or royal foot, the 600dth part of the Philæterian stadium [u], is considered by De Romé de l'Isle to be the same as the palmipes, which consisted of 20 digits, being made up of the geometrical foot of 16 digits and the palm of 4 digits. The palmipes is considered by others to be made up of the Roman foot and the Roman palm, which would make its dimensions a trifling degree greater. On the former hypothesis, the palm is calculated as the sixth part of the common cubit. The following table will serve to facilitate the comparison of the different measures.

Names of measures.	Digits	Parts	Inches	Lines	100ths of a line
Palm	4	307	2	6	70
Geom. foot	16	1233	10	3	31
Capitoline, or Roman foot	$16\frac{3}{5}\frac{1}{2}$	1306	10	10	60
Philæterian foot, or palmipes	20	1542	12	10	18
English foot		1352	11	3	25
French foot		1440	12		
Venetian foot		1541	12	10	10
Veronese foot		1490	12	7	

[u] The Philæterian stadium was the 318,000th part of a degree: it is supposed to have been introduced by Philetærus, the founder of the kingdom of Pergamus, B. C. 283.

The measurements are in French inches, &c., there being 12 lines to an inch. The proportion of the English to the French foot is now determined to be as 10000 to 10659, whereas that given by De Romé de l'Isle is as 10000 to 10649. The difference, however, is not of much consequence, as far as the calculations here are concerned.

The seats, then, according to Vitruvius, were not to be less in height than a palmipes, or 20 digits, nor greater than a foot and 6 digits (22 digits): in breadth not greater than 40 digits, nor less than 32. If we therefore adopt the calculation of De Romé de l'Isle as to the length of the palmipes, it corresponds almost exactly with the Venetian foot; and on this supposition the height of the seats falls within the prescribed limits of 20 and 22 digits, being nearest to the maximum, as 13 Venetian inches fall very little short of 22 digits. If, on the other hand, we assume the palmipes to be made up of the Roman foot and the Roman palm, its length will be 13 inches 6 lines 50 cents French; and as 13 Venetian inches are 13 inches 10 lines 94 cents French, the seats on this supposition approach the minimum. On this hypothesis, the maximum must be considered as made up of the Capitoline or Roman foot *plus* six digits; but I am rather inclined to adopt the calculation of De Romé de l'Isle, as on the other hypothesis the difference between the maximum and minimum will be a fractional portion of 2 digits[x], instead of an integral number of digits. In either case however the proportions of the seats harmonize with the directions of Vitruvius.

[x] Or 1 inch 2 lines 65 cents French.

This circumstance is of the greater importance, as at Nismes, according to Maffei, and at Verona, the heights of the seats are about 26 digits. I would however observe, that, although the pride of the Veronese in their amphitheatre is founded on the whole range of its seats being entire, great numbers of them are comparatively modern, and none can be considered as coeval with the building itself. My own measurement of these seats made them out to be on the average $14\frac{1}{2}$ English inches in height, the same as at Pola; but Maffei was a native of the place, and had many opportunities of verifying his calculations. Torelli, however, gives the height of them as 14 inches, probably in Veronese measure, and in that case equal to 14 inches 8 lines 50 cents French [y]. It may certainly have happened that Maffei, in his interpretation of the passage in Vitruvius, adopted the same idea as Stancovich, which I cannot but consider as erroneous, and imagined the foot, which is spoken of after the palmipes, to be the same as the palmipes, a foot of 20 digits, so that he made out the maximum height allowed by Vitruvius to be 26 digits, and took the greatest measurements that he could find in Verona. I observed in that amphitheatre that under many of the seats small pieces of brick, &c. were introduced. It would be a curious subject of investigation, whether the object of this was merely to supply what the ravages of time had wasted away, or to raise the seats somewhat higher at the time when the building was repaired, and

[y] Torelli's measurements, I find, were in French feet: 14 inches French are but in a trifling degree greater than 13 inches Venetian.

thus to make them appear to confirm the interpretation of Maffei.

Out of the whole number of forty-three seats, or fragments of seats, which have been found at Pola, nineteen are $13\frac{1}{2}$ Venetian inches in height, and the remainder somewhat exceed this measurement in a greater or less degree. The most obvious way of accounting for these variations is this: that as one side of the amphitheatre was on the slope of a hill, the material of which is hard limestone, the irregular heights of these seats may have been adapted to different parts of the surface of the rock, where it was requisite to provide such a resource against accidental inequalities. The minimum height of the seats is by no means an inconvenient one, but they were probably raised somewhat higher by a layer of boards for the less privileged orders, and by cushions for the dignitaries of the place [z]. Not only, however, was the height of the seats not considered inconveniently low, but the reverse occasionally, as stools for the feet to rest upon are also alluded to by Ovid [a]. The object of these stools was no doubt partly to keep the knees of the spectators from interfering with the comfort of those who sat on the tier of seats below them.

With regard to the breadth of the seats, the maximum was, according to Vitruvius, 2 feet 8 digits, the minimum 2 feet. Accordingly at Pola the nineteen seats above-mentioned are exactly 2 Venetian feet in breadth, or 2 palmipedes, (40 digits,) the maximum allowance: beyond this the stone is still

[z] Dion Cassius, l. lix. c. 7. Juvenal, iii. l. 153. Plautus Stichus, act. i. sc. 3.

[a] Et cava sub tenerum scamna dedisse pedem.

carried on, being lowered about half an inch, so as to allow the seat above to fit into it. The greater breadth of some of the other seats was perhaps requisite to give firmness to the building, by allowing the seat above to project further over that immediately below it, where the surface of the rock did not afford an adequate support to it. On two of the seats, which were evidently at the extremity of a *cuneus*, there are steps cut for the spectators to ascend by. These steps are seven inches French in height, about the same that Torelli has given for those at Verona, *nec alti plus quam uncias septem.* The breadth of the seats at Verona I ascertained to be 26 English inches, somewhat less than the maximum of 40 digits. This may be considered as a decisive confirmation of the opinion of those who agree with Carli, in fixing the minimum at 32 digits in opposition to Stancovich, who interprets the "pes" throughout the whole passage in Vitruvius as the "palmipes," and thus fixes the minimum at 40 digits, or 29 English inches.

In the following table, the dimensions of the amphitheatre at Pola are given in juxtaposition with those of the amphitheatres at Verona, Nismes, and Rome.

	Pola.	Verona.	Nismes.	Rome.	
	Stancovich.	Maffei.	Menard.	Fontana.	
Major axis ext.	394	450	391	564	Veronese Feet.
Minor.	316	360	306	467	
Major ax. arena.	201	218.6		273	
Minor.	123	129		173	
Ext. circumference.	1127	1290	1101	1566	
Height.	89	110	63	140	
Number of arches.	72	72	60	80	
Tiers of seats.	35	43	35	67	

We may here observe, that the same proportion is maintained at Pola, Verona, and Nismes, between the exterior major and minor axis, which are all but accurately in the ratio of 5 to 4 to each other. (Vide Appendix.)

The discovery of the lines upon the seats, by which it appears that a space of 13 Venetian inches only was allowed as sitting room to each person, furnishes us with fair data for calculating the number of spectators that these amphitheatres would contain. Maffei, in his calculation of the contents of the theatre at Verona, allowed to each spectator a foot and a half of Veronese measure, nearly one third more than was allowed at Pola. On this hypothesis he estimated that the amphitheatre at Verona would hold 22,000 spectators. If his method of computing the number be assumed to be correct, it is evident that with our new data, the sum will come out much greater for the number of spectators, as 22,000 multiplied by 18 Veronese inches will equal $14\frac{1}{2}$ English inches multiplied into the sum required. So that by a common[c] proportion we have

4901 : 6705 : : 22,000 : 30,097.

This is an important difference, if the number of spectators, that the amphitheatres could contain, is to be considered any criterion of the size of the towns, or of the population of the neighbourhood. During the congress at Verona, horseraces were exhibited in the arena of the amphitheatre; and when the course had been railed off, spectators were admitted to the seats, and to the centre part of the arena within the

[c] There are in 18 inches Veron. 2235 equal parts, of which there are $1633\frac{2}{3}$ in $14\frac{1}{2}$ English inches, so that the proportion is easily obtained from this.

course. It was ascertained by the tickets received at the entrance that 60,000 persons were admitted on this occasion.

At Nismes again, M. Menard made his calculation, allowing 16 inches French for each spectator; and on this hypothesis computed, that the amphitheatre there would contain 22,820 spectators, and that as probably only about a fourth of the inhabitants were present, the population of Nismes might be rated at 80,000. There is however an evident fallacy in this latter supposition, as no allowance is made for the inhabitants of the neighbouring country, who would of course flock in to the spectacle. We will however assume, that, excepting his data, his computation is made correctly, and we shall then have, in a similar manner as before, this proportion[d],

4901 : 5760 : : 22,820 : 26,799.

So that, from the new data that the discovery of these lines affords us, we may estimate the number of spectators at Nismes at about 4000 more than what M. Menard has assigned.

Stancovich calculates from the new data that Pola had accommodation for 26,000 persons; but as the amphitheatre there is somewhat greater in dimensions than that at Nismes, and its tiers of seats equal in number, his computation must evidently have been made on a more moderate scale than that of Menard. Menard having measured the greatest and least circumference of the seats, takes a mean proportional, and multiplies this by 35, the number of the tiers of seats, and thus obtains the number of persons by dividing this product by the space that

[d] There are in a French foot 1440 equal parts, of which there are in an English foot 1352.

he allotted to each person. Unfortunately, in the absence of these measurements at Pola, we cannot compare the numbers so accurately as might be wished; for with the only data [e] that Stancovich affords us, the numbers come out much less than 26,000. If, however, we look at the proportions of the axes here, as compared with those at Nismes, we may fairly consider that the amphitheatre would contain about 27,000 spectators.

The Coliseum at Rome is said to have held 85,000 spectators. This statement, although assailed by Maffei, who reduces it to 50,000, and by Giacomo Rucca, who brings it down to 34,000, the number which he assigns to the amphitheatre at Capua, is confirmed by the measurements of Lucangeli, whose celebrated model of the Coliseum is well known to most of those who have visited Rome.

I should state, that the three uppermost rows of seats at Pola are supposed to have been constructed of wood, a kind of gallery, such as is believed to have been generally fitted up in amphitheatres. Revett describes the upper part thus: "On the exterior, between the windows, are holes in the plinth, evidently for the supporters of the velum. The top is at present without mouldings, a singular finish, and in the interior there is a series of holes corresponding to those on the outside, with an additional one in the middle of the windows. It is not impossible that this amphitheatre had a portico of wood

[e] External circumference of the building 1090 Venetian feet; circumference of the arena 493 feet. Maffei, however, gives 1110 for the outer circumference, whilst his dimensions for the axes are less than those of Stancovich; so that the measurements cannot be sufficiently depended upon.

on the upper part, as directed by Vitruvius in theatres, but of which no vestige, I believe, remains in any existing ruin. A gutter extending along the top between each window, with triangular openings on the outside, as spouts to carry off the water, justifies the idea." From an inscription at Rome respecting the Fratres[f] Arvales, priests appointed to offer up sacrifices for the fertility of the soil, we learn that there was a similar wooden gallery in the Coliseum, as a certain number of places are enumerated as assigned to them in the first and second menianus, on the stone seats, (*gradibus marmoreis,*) and in the highest menianus on the wooden benches, (*in ligneis.*)

There is another peculiarity connected with the seats in this amphitheatre, that on several of them letters are engraved, as if to denote that they were private seats. It is well known, as we have just seen in the inscription respecting the Fratres Arvales, that certain seats were set apart for magistrates and corporate bodies; but it is not so clear that individuals were allowed a proprietary interest in seats. On the theatre at Syracuse there are some Greek characters engraved on the back of some seats, which lead to the supposition that they were assigned to distinguished personages, as three[g] inscriptions may be deciphered, but we have here the inscriptions in full, and not mere letters. Stancovich, however, has ingeniously endeavoured to find the owners for these seats at Pola, by identifying the

[f] Marini. Gli atti dei Fratelli Arvali. Roma, 1795. p. 219, 224. Tav. XXIII.

[g] ΒΑΣΙΛΙΣΣΑΣ ΝΗΡΗΙΔΟΣ. ΒΑΣΙΛΙΣΣΑΣ ΦΙΛΙΣΤΙΔΟΣ. ΒΑΣΙΛΕΟΣ ΙΕΡΩΝΟΣ.

initials on them with the names of persons, which occur in inscriptions at Pola or in the neighbourhood. His idea, that they were the private property of individuals, has some confirmation in M. Artaud's statement, that he found some inscriptions at Nismes, which he was led to suppose intimated places of honour for certain families; and on the amphitheatre at Pompeii we have inscriptions at full length, intimating that seats were assigned to individuals as marks of honour. How valuable the privilege of a private seat may have been, can be imagined from the fact, that places were not unfrequently occupied the night[h] before.

It now remains to determine the age of this amphitheatre. I am myself inclined to the opinion that the amphitheatres at Pola, Verona, and Nismes were all constructed about the same period. The style is the same in all, rusticated; the order of architecture, Tuscan. No cement or mortar is used in any of the three. The thickness of the walls at Verona and Pola, and, as I believe, at Nismes, diminishes from the inside, whereas in the Coliseum it diminishes from the outside. The latter plan Serlio considers to give more strength, the former more room. At Pola and Verona there are 72 arches, at Pola and Nismes there are 35 rows of seats. Pola, Verona, and Nismes were all Roman colonies.

The history of Pola is carried back by tradition

[h] Suetonius Caligula, c. 26. Inquietatus fremitu gratuita in circo loca de media nocte occupantium, omnes fustibus abegit. Elisi per eum tumultum viginti amplius equites Romani, totidem matronæ, super innumeram turbam cæteram.—The Circus Maximus is here alluded to, which lay between the Palatine and Avertine hills, and was overlooked from the palace of the emperor.

to the Argonautic expedition, as its foundation is referred to a detachment of Colchians, who had been dispatched in pursuit of the conquerors of the golden fleece. When Istria surrendered to the Roman arms, U. C. 573, Pola of course lost its independence. We find it afterwards spoken of as a Roman colony by the elder Pliny, who, after enumerating the municipal towns of Istria, goes on to mention, *Colonia Pola, nunc Pietas Julia, olim a Colchis condita.* The medals dug up in the neighbourhood are all of the time of the first emperors. The beautiful temple of Rome and Augustus, the portico of which is one of the most exquisite specimens of Corinthian architecture, and the corresponding temple of Diana, evidently of contemporaneous origin, are evidence that the taste for architectural display, and the wealth requisite to indulge that taste, were found here as early as in the reign of Augustus. There are other ruins evidently both of an earlier and later date, but there is no token [i] about the amphitheatre which would serve to determine accurately the time of its erection. The question therefore resolves itself into one of probability.

The earliest *stone* amphitheatre that we read of was built by [j]Statilius Taurus, in the reign of Augustus, from the encouragement of that prince; nor does this appear to have satisfied the wishes of Augustus, as he is said by [k]Suetonius, to have formed

[i] I did not observe anywhere on this amphitheatre the bull's head, the symbol of a colony, which may be observed on those at Nismes and Verona. It might be argued from this, that the building was constructed prior to the time when Pola was made a Roman colony.

[j] Dion Cassius, LI. c. 23. This was U. C. 724.

[k] Suetonius, Vespasian, c. 9.

the design of an amphitheatre in the midst of the city, which Vespasian afterwards executed. Tiberius made use of the amphitheatre of Taurus, and Caligula likewise, but this latter prince commenced a new amphitheatre[l] near the Septa. This work, however, was discontinued by Claudius, who directed the wealth and labour of the nation to a more useful object, the Claudian aqueduct. Nero was satisfied with a wooden amphitheatre, which he built in a year's time, as that of Taurus was burnt down in his reign. His passion for architectural display found a vent in his golden house. The subsequent emperors, till the accession of Vespasian, seem to have had neither the inclination nor the leisure for such works.

Maffei founds his argument against the early origin of these amphitheatres, on the improbability of the colonies having had stone amphitheatres before the building of that of Vespasian at Rome, which was dedicated by Titus in the last year of his short reign, and thus he would make them all posterior to the year 80 of the Christian era. Fortunately a specimen exists to which he had no access, and against which his doctrine is of no avail, the amphitheatre at Pompeii, the date of which is certainly anterior to 60, A. D. In the first place, this amphitheatre bears marks of having suffered by the earthquake of 63, A. D., as supports and bulwarks of various kinds have been added to it, and there is an inscription assigning places of honour to some individuals, who had contributed to the restoration of it: and in the second place, we are informed by Tacitus[m], that in the year 60, A. D., a murderous dispute

[l] Ib. Caligula, c. 21. [m] Annal. l. xiv. c. 17.

arose at Pompeii, between the inhabitants of that town and the Nucerians, at a gladiatorial show exhibited by Levineius Regulus, in which the Nucerians had the worse, as the Pompeians were able to procure arms. In consequence, the Pompeians were prohibited by a decree of the Roman senate from holding such assemblies for ten years. The presence of the Nucerians at this show, is evidence that the inhabitants of the neighbouring towns formed part of the spectators, for whose accommodation the dimensions of these buildings were in general calculated. So far, then, the opinion of Maffei is without foundation.

We have, however, no actual data to enable us to determine accurately the epoch at which this amphitheatre at Pompeii was constructed. It would seem, however, to have been built before the smaller covered theatre or Odeum, as the names of C. Quinctius Valgus and M. Porcius, the duumvirs who built the latter, are inscribed on the amphitheatre as having exhibited some games to the colonists at their own expense, when duumvirs. There was also found a statue of C. Cuspius Pansa at the entrance of the amphitheatre, and an inscription recording a magistracy which he had discharged according to the Petronian law. The object of this law [n] was to prohibit masters from compelling their slaves to fight in the arena with wild beasts, unless previously condemned

[n] Vide Noordkerk, disquisitio de lege Petronia, where he says, in allusion to the coins of the Petronian family, "Næ dici vix potest quî hæc cum Seneca conveniant. Ait Philosophus, positum fuisse qui et sævitiam et in præbendis ad victum necessariis dominorum avaritiam compescat." (Vide Seneca, de Benef. iii. c. 22.)

by the tribunals. It is not agreed in whose reign this law was passed. Heineccius and others refer it to C. Petronius Sabinus Turpilianus, who was consul in U. C. 814, during the reign of Nero; but Haubold and others with greater probability, I think, to an individual of the Petronian Gens, who lived in the reign of Augustus. In this case it must be referred to P. Petronius Turpilianus, and the law seems to have been commemorated by family coins, in the same way as the Mamilian and the Papian Poppæan. Of these we have two remarkable coins in the British Museum. One has on the obverse the head of Augustus, and on the reverse a man standing *cum patera et flagro*[o], with the legend *P. Petronius Turpilianus* $\overline{III}$ *vir;* the other has on the obverse the head of Augustus, and on the reverse the head of Feronia[p], the goddess to whom slaves offered up their vows in the hope of liberty, with the same legend round it, as on the other coin. That there may have been ample occasion for such a law in the reign of Augustus may fairly be presumed from Seneca's[q] account of the cruelty shewn on the most ordinary occasions to slaves; and its promulgation would be in accordance with the general character of that prince, and the spirit of his legislation. On the other hand, it is not very probable that an emperor like Nero[r], who could compel

[o] As described by Rasche in his Lexicon Rei Numismaticæ.

[p] The temple of Feronia was at Terracina, (Horat. 1. Sat. v. l. 24.) and on a seat before her altar the following words were inscribed, "Benemeriti servi sedeant, surgant liberi." It was not unusual for fortunate slaves to dedicate altars to this goddess.

[q] Seneca de Ira. iii. c. 40. de Clement. i. c. 18.

[r] Sueton. Nero, c. xii. Juvenal. Sat. i. l. 156.

Roman senators and knights to fight with wild beasts in the arena, and could burn human beings at the stake, should have felt any romantic compunctions for the sufferings of slaves, whom their masters had pronounced worthless. It is on these grounds that I am inclined to agree with Haubold, and to suppose that this inscription [s] at Pompeii refers to the reign of Augustus, and to the officer on whom the duty of "Protector of Slaves" devolved according to the Petronian law.

The amphitheatre that we read of in Tacitus and Suetonius, the fall of which entailed such a dreadful loss of life in the reign of Tiberius, was certainly a temporary wooden one, like that of Nero's [t], in the Campus Martius. Tacitus, however, makes mention of a noble amphitheatre at Placentia [u], that was destroyed by fire in a conflict in the suburbs of that town between the troops of Otho and Vitellius, and states, that the common people there believed that it had been maliciously set on fire by some of the inhabitants of the neighbouring towns, from jealousy of its being the most capacious building of the kind in Italy. Maffei acknowledges the obvious inference from this, that there were at that time several large amphitheatres in Italy, but contends that this building must evidently have been constructed of wood, from its being destroyed by the

[s] C. CUSPIUS. C. F. PANSA. PATER. D. V. I. D. IIII. QUINQ. PRAEF. ID. EX. D. D. LEGE. PETRONIA, which may be interpreted, "duumvir jure dicendo quatuorvir quinquennalis præfectus idem ex decreto decurionum lege Petronia."

[t] Ann. iv. 62. Sueton. Tib. xl.

[u] Hist. ii. c. 21.

fire. In reply to this it may be urged, that if it was merely a wooden building, it is improbable that its loss should have been so severely lamented by the rich town of Placentia, as Tacitus informs us was the case, since amphitheatres, of wood most probably, were constructed at Cremona and Bononia by the soldiers of Cæcina and Valens, within the short space of forty days, after the battle of Bebriacum, in order that the triumphant entry of Vitellius into Italy might be welcomed with shows of gladiators, his favourite amusement. In the second place, it by no means follows, from the circumstance of the conflagration, that it was a wooden building. For in the reign of Macrinus, A. D. 218, the Coliseum was struck by lightning; and Dion Cassius[x], who witnessed the conflagration, informs us, "that it was burnt from top to bottom; that all the upper gallery, which perhaps comprised a construction of woodwork raised on the top of all we now see, was consumed, and all the seats likewise; and notwithstanding the quantity of water which was brought to extinguish the fire, added to the abundance of rain which fell in the thunder-storm, the building was so effectually destroyed, that for several years it could not be used for exhibitions." The succeeding emperors contributed to its restoration; but we hear of no more shows exhibited there until the emperor Philip celebrated the secular games, A.D. 248[y]. I do not therefore conceive that the words of Tacitus at all prohibit the conclusion that this amphitheatre at Placentia was a stone-

[x] Liber lxxviii. c. 25.

[y] Vide Burgess, Antiq. of Rome, Dissert. v.

building, but rather the reverse, and that there may have been several other stone amphitheatres in the north of Italy about the same period.

If, however, any argument may be founded on the similarity of the amphitheatres at Pola, Nismes, and Verona, both in the style and order of their architecture, which seems by no means unallowable, as such a similarity both in their proportions and workmanship may be observed in the contemporaneous amphitheatres of a later period[z], we shall perhaps be nearer the solution of our original question, if we can determine the period at which the amphitheatre at Nismes was erected.

We have then at Nismes the temple known by the modern appellation of *La Maison Carrée*. This was for some time supposed to be the Basilica of Plotina, built by Adrian; but it is now decided to have been constructed in the reign of Augustus, and to have been dedicated to Caius and Lucius Cæsares, the adopted sons of Augustus, who were honoured with the title of *Principes Juventutis*[a]. Again, the aqueduct, not far distant from Nismes, known as the *Pont du Gard*, is conjectured to have been commenced by Agrippa, in his office of *Curator Aquarum*, in the year U. C. 735, when he was resident in Gaul, and to have been completed in U. C. 750. The colony at Nismes had been established as early as U. C. 727, when Augustus was marching through Gaul against the Asturians

[z] Such as those built in the provinces by the Antonines.

[a] A similar temple was erected in honour of them at Rome. Sueton. Aug. xxix.

and Cantabrians, and was composed of veterans from the army of[b] Egypt. Agrippa likewise superintended its organization.

Assuming, then, that the supposition is correct as to the *Maison Carrée* having been dedicated to Caius and Lucius Cæsares, we perceive by the inscription on the portico, according to the deciphering of it by M. de Seguier[c],

C. CÆSARI AUGUSTI F. COS. L. CÆSARI . AUGUSTI . F.
COS. DESIGNATO PRINCIPIBUS JUVENTUTIS,

that Caius is spoken of as consul, and Lucius as consul elect. This then must have been between the years 754–757, as Caius, having been declared consul elect in 749, entered upon office as consul in 754, and Lucius had been declared consul elect in 752. They were both declared consuls elect in their fifteenth years, as we may learn from the Ancyran[d] monument, and remained for five years in that state of probation, during which however they were privileged to be present at the public councils.

But there are some other circumstances, which serve to connect the epoch of this temple with that of the amphitheatre; and amongst others, the following inscription, found in 1810 near the amphitheatre:

C. C. AVGVSTI. F. PATRONVS . COL
XYSTVM . DAT.

If the word *xystus* may be here interpreted according to the sense which Vitruvius attaches to it,

[b] The medals of Nismes bear on the obverse the heads of Augustus and Agrippa averse and the letters P. P.; on the reverse a crocodile chained to a palm tree, and the letters COL. NEM.

[c] This inscription was ingeniously deciphered by fitting metal letters to the holes and marks on the frieze of the architrave.

[d] Tacitus, Oberlin, vol. iv. p. 841.

l. v. c. 9, as a covered portico, in which the athletæ were exercised in winter, it would not be unfair to conclude that these exercises were carried on with reference to exhibitions in some public place, and hence that there was an amphitheatre for such exhibitions built at a period preceding, or at least contemporaneous with the establishment of the training ground.

Some additional light may be thrown upon this subject by a fragment of an inscription found in the arena in 1809, with the words VIII. TRI. PO. as if alluding to the eighth year of the enjoyment of the tribunician authority by one of the emperors. Those who deny the existence of amphitheatres *at all* in the provinces till after the reign of Tiberius, and of *stone* amphitheatres there till the reign of Vespasian, conclude from this inscription, which they suppose to refer to the emperor in whose reign the amphitheatre was built, that the amphitheatre must have been built in the reign of Vespasian, Titus, or Domitian, as none of the emperors between Tiberius and Vespasian enjoyed the tribunician authority eight times. But if the first hypothesis is unfounded as to the provinces not possessing amphitheatres till after the reign of Tiberius—for it is only an assumption, and may be as baseless as the second hypothesis, which has been proved to be false by the evidence of the amphitheatre at Pompeii—we may find a more obvious explanation of these words.

On a gate at Nismes, known as the gate[e] of Augustus, there is the following inscription:

IMP. CAESAR . DIVI. F. AVGVSTVS. COS. XI. TRIBV.
POTEST. VIII. PORTAS. MVROS. COL. DAT.

This gate seems to have been erected by Augus-

tus, when he had enjoyed the consular office for the eleventh time, and when invested with the tribunician power for the eighth. It is not an overstrained hypothesis to refer the inscription found in the arena to the same epoch. The eighth year of Augustus's tribunician authority began June 27, U. C. 738, and expired June 26, U. C. 739. He had discharged the office of consul for the eleventh time in 731, and did not again assume it till 749; so that we can here accurately determine the period to which the inscription on the gate refers. But in this very year 738, Augustus in person visited Gaul[f], having appointed Statilius Taurus viceroy of Italy, and having dispatched Agrippa on his second expedition into the East. Agrippa had himself been in Gaul in 734, on his way into Spain to quell an insurrection of the Cantabri, which he accomplished either in that or the following year. How long he remained in Gaul is uncertain, but it may have been on his victorious return from this expedition that the foundations of the amphitheatre were laid. It may thus have been completed at the time when Augustus visited Nismes, who may have presided at the dedication of it, or at all events was present on the occasion which the inscription appears to commemorate.

With regard to Verona, a military colony had been settled there as early as U. C. 666; and the importance of this town may be inferred, from its being selected as the pivot, upon which the armies

[e] Amongst the other ornaments of this gate are two bulls' heads, the symbol of a colony, which I merely allude to as being likewise to be observed over the northern gate of the amphitheatre.

[f] Dion Cassius, lib. LIV. c. 19.

of Vespasian were to move in the expedition against Vitellius. Pliny, in his letter to Maximus, does not allude to the amphitheatre at Verona as either a new or singular ornament to the town; and we know from the various inscriptions that have been discovered, that this town was both able and inclined to indulge in architectural display in the reign of Augustus. The argument here, however, is not of a *positive* character, as far as records are concerned, but must chiefly rest upon the identity of the style of the building with that at Nismes.

At Pola likewise we have no *positive* evidence, excepting so far as to prove that the taste for architectural magnificence had diffused itself here in the reign of Augustus. Were I called upon to assign any period in the reign of Augustus as that in which it is most probable that the amphitheatre here was constructed, I should be inclined, from the staircases to which I have alluded as a peculiar feature in this building, to fix upon a period not long after the decree of Augustus which Suetonius records, by which females were no longer allowed to sit in the body of the house, but were confined to the upper circles. This regulation was perhaps one amongst others in the *Lex Julia Theatralis*. The year, in which this law was passed, is not precisely known; but it was most probably either the year 737, U. C., when the secular games were celebrated, and when by the *lex Julia de maritandis ordinibus* [g] seats of honour were assigned to the married men, or the year 741, U. C., when the pontifical games were celebrated by Augustus on his assuming the title of *Pontifex Maximus*. On this occasion he forbade females to be present at the shows of

[g] Then first promulgated, but not passed into a law till 757.

the athletæ, and may have limited their privileges in other respects. I should, however, rather incline to the earlier date, from the manner in which Suetonius relates the two circumstances. If this hypothesis be correct, the amphitheatre at Pola must have been commenced not long after that at Nismes was completed. We may fix upon the same period as that about which the amphitheatre at Pompeii was constructed. The *lex Petronia* which is recorded there, was passed, according to Haubold, in U. C. 763; and it is not improbable that the statue of Pansa was erected there soon after the law was passed, perhaps in commemoration of the magistrate on whom the pleasing office first devolved of mitigating the horrors of the arena.

The argument, then, which I have endeavoured to substantiate, may be summed up in these words. That it is by no means improbable that permanent stone amphitheatres were built in the colonies and municipal towns in the reign of Augustus: that the law of Petronius was passed in that reign, and would be more particularly called for on this supposition: that the amphitheatres at Pola, Verona, and Nismes, from their similarity, I may say identity, of style, are of contemporaneous origin; that their style is evidently anterior to that of the Coliseum built in the reign of Vespasian, or of the amphitheatre at Capua, which was built by that colony in imitation of the Coliseum, and dedicated by Antoninus Pius: that there is evidence almost of a *positive* nature that the amphitheatre at Nismes was built in the reign of Augustus: that the amphitheatre at Verona is not spoken of by Pliny as by any means new or strange in his time, and that the town was sufficiently wealthy to raise such a

building, and also did evince a taste for architectural display in the same reign: that at Pola the temple of Augustus, and other buildings, lead to a similar inference: and that the encouragement given by Augustus to the building of such edifices was greater than that shewn by any other prince.

We have likewise positive evidence that Agrippa built many of the most splendid edifices in Rome; and that this was apparently so far a family taste, that his sister Pola built a portico and embellished the race course. That he was particularly interested in Nismes may be inferred from the works which he executed there, and from his son Caius being patron of the colony. I will not venture to assert that Statilius Taurus, when appointed prefect of Italy in 738, U. C., encouraged the building of amphitheatres; or that Pola, the sister of Agrippa, was likely to have contributed to the embellishment of a town which bore her name; but this, I think, may be maintained, that there is no evidence of so conclusive a nature as to warrant us in referring these buildings to the age of Trajan or of the Antonines, but that the probability is in favour of a much earlier date, both from the known encouragement given to such works by Augustus, the architectural remains of buildings decidedly raised in these towns during his reign, and the style of the amphitheatres themselves, clearly of an age less fond of ornament, and less corrupt in its taste, than that even of Vespasian and Titus.

APPENDIX.

On the oval form of the arena in Amphitheatres.

THE form of all amphitheatres is an oval, more or less approaching to an ellipse, and in some cases said to be per-

fectly elliptical. The reason why this figure should be preferred to the circle admits of two explanations. The first and most obvious is, that it was more commodious for the spectators: "parcequ'elle était la plus avantageuse et la plus propre à faciliter et rendre générale à tous les spectateurs la vue des exercises." Such is the opinion of Mr. Ménard, which is partially confirmed by Cassiodorus[a]. The second reason is, that in an arena of this form the combatants would be able to retreat from, and advance upon each other through a greater space, and thus afford more excitement and amusement to the spectators. I might likewise add a third reason, that the majority of the spectators would be more comfortably arranged than in the spoke-like fashion of the radii of a circle. These arguments, however, only tend to shew that the circle was not the best figure, and not to explain why an oval of fixed dimensions should generally have been adopted. On this subject I will venture to suggest a few hints, not as decisive of the question, but as appearing to throw some light upon it.

The amphitheatre was merely two theatres without their stages, united at the stage extremities. The first that we read of was that of Curio[b], who, unable to rival Æmilius Scaurus in the splendour of his theatre, devised the novel scheme of two large theatres of wood adjoining each other, and suspended on hinges; in both of which he acted stage-plays in the morning, and in the evening, having wheeled them round, formed thus an amphitheatre, in which he exhibited shows of gladiators. This likewise is confirmed by Cassiodorus[c]. The earliest fixed amphitheatre, however, was built by Julius Cæsar of wood, and is spoken of by Dion Cassius[d] as a hunting theatre, and, according to him, received the name of amphitheatre, from there being seats all round without any stage: we may thus then consider the amphitheatre as made up of two theatres. There were,

[a] Cassiodorus, Variar. l. v. Ep. 42. Ovi specie ejus arenam concludens, ut concurrentibus aptum daretur spatium et spectantes omnia facilius viderent, dum quædam prolixa rotunditas universa collegerat. [b] Pliny xxxviii. c. 15.

[c] Cassiodorus, ibid. Cum theatrum, quod est hemisphærium, Græce dicatur, amphitheatrum quasi in unum juncta duo visoria recte constat esse nominatum. [d] Dion Cassius, 43. c. 22.

however, two kinds of theatres, the Roman and Grecian, the proportions of which were different, as in the former the object was to have as wide a stage as possible, since all the actors appeared on the stage; in the latter, since the chorus danced in the arena, it was desirable to have as deep an orchestra as possible. The proportions are given by Vitruvius, both of the Roman and Grecian theatre [e]. In the former the stage was marked off by the base of an equilateral triangle described in the arena, in the latter by one of the sides of a square. This enables us easily to calculate the depth of the orchestra in both cases. As the dimensions of the *arena* in the amphitheatre would doubtless be mainly looked to, we should, *à priori*, conclude that the Greek rather than the Roman theatre would be the element of the amphitheatre, as the dimensions of the arena in the former are greater [f]. If this conclusion be correct, the proportion of the greater to the less axis in the amphitheatre would be as 3.4142136 to 2, or nearly as $3\frac{4}{10}$ to 2. On examining the major and minor axes of the arena at Verona, the proportion appears to be as 218.6 to 129, which is strikingly accurate, for 218 is to 129 as $3\frac{4}{10}$ to 2. At Pola the proportion of 201 to 123 is not quite so accurate, since $196\frac{8}{10}$ is to 123 as $3\frac{4}{10}$ to 2. It is, however, so close an approximation as to be strongly confirmatory of the hypothesis. I have unfortunately no data in the case of Nismes. The proportions of the arena of the Coliseum are not the same, but this is what we should not be surprised at, if the age of the other three amphitheatres has been rightly determined.

[e] Vitruvius, lib. v. c. vi. c. viii.

[f] In the Roman theatre if a diameter be drawn across the arena, parallel to the stage, the distance from that diameter to the stage = sine of $30° = \frac{1}{2}$, or .5000000. In the Greek it = sine of $45° = \sqrt{\frac{1}{2}} = .7071068$, so that on the supposition that the amphitheatre was made up of two Greek theatres, the major axis of the arena would exceed the minor by twice this quantity, or would be to it in the proportion of 3.4142136 to 2.

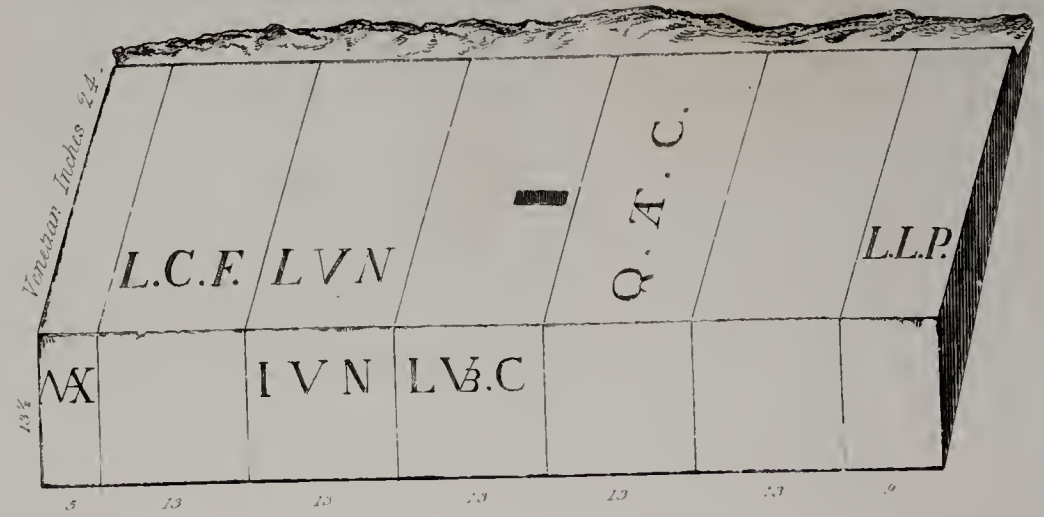
T. Allason.

G. Hollis.

GENERAL VIEW OF POLA.

T. Allason. G. Hollis

THE AMPHITHEATRE



Stone seat discovered in the Arena.

ON THE

COLLECTION OF BORACIC ACID

FROM THE

LAGONI OF TUSCANY.

BY

THOMAS TANCRED, M.A.

FELLOW OF MERTON COLLEGE.

OXFORD,

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ON THE

COLLECTION OF BORACIC ACID

FROM THE

LAGONI OF TUSCANY.

READ TO THE ASHMOLEAN SOCIETY, NOV. 20, 1837.

THE most remarkable natural phenomenon, of the many which are worthy of observation in the part of Tuscany called the Maremma [a], is the production of Boracic Acid from steam, which issues from the ground charged with that substance. This is the only spot in the world from whence this acid is obtained in a natural state, the salt called Borax, previously known in commerce, being brought from Thibet, where it is understood to be found in certain lakes, and as an incrustation on the ground, but certainly in a very impure state.

Borax appears to have been known to the Hebrews, Greeks, and other nations of antiquity, by names very nearly identical with that which it still bears. It is supposed to be the Chrysocolla of Pliny, being so called from its great use as a flux in soldering metals. Its present name is that given to it by an

[a] The maritime district included between the Cæcina on the north, the sea on the west, the Roman road through Siena on the east, and extending on the south into the Roman states.

Arab chemist, Geber, in the 10th century. Though extensively employed in the arts, little or nothing was known either as to whence it was derived, or of its nature, before the beginning of the last century. It was known to be brought from some country in the East under the name of Tincal, mixed with a soapy substance, from which the Venetians had the secret of purifying it, a process which was afterwards carried on in Holland, by means of repeated washings, dissolutions, and crystallizations. At length (in 1702) some light was thrown on the true nature of this substance by an accidental decomposition of some, by the chemist Homberg, who thus for the first time obtained Boracic acid. It was only sixty years ago, in 1776, that Hoëffer first discovered the existence of Boracic acid in a natural state, in the waters of a lake near Monte Rotondo in Tuscany, which I visited in the spring of this year. By combining this natural acid with soda he succeeded in artificially composing Borax, which was thus proved, analytically and synthetically, to be a *sub-borate of soda* [b]. Lastly, in 1808 and 9, Gay Lussac, Thenard, and Sir Humphry Davy, proceeded a step further by decomposing the Boracic acid, and were thus enabled to study its base, called *Borium* [c].

Borax usually assumes, when pure, the form of a hexahedral prism compressed, and terminated by a trihedral pyramid. It will dissolve in twice its weight of water, if boiling, but requires much more water if cold. Its transparency is gelatinous and

[b] Fourcroy's Chemistry.

[c] Philosophical Transactions, 1809. and Thompson's Chemistry.

fracture glassy. It effloresces when exposed to the air, which arises from its containing half its weight of water of crystallization, and which also causes it to swell up when exposed to a strong heat, after which it melts into a glass, at first limpid, but afterwards becoming dull [d].

Borax is extensively used as a flux in causing other substances to melt, and is thus very useful in soldering metals, by causing those particles in immediate contact with it to melt at a less heat than is sufficient to fuse the adjacent parts, which are not exposed to its influence. This property makes it of great use in reducing substances before the blowpipe, and also in causing the glaze on china and pottery to run, and in the manufacture of glass and enamel. Boracic acid might also be extensively employed in dyeing, were its price less high.

It was before observed, that Borax was for many ages brought from some country in the East, but the place where, and the circumstances under which it was produced, remained involved in mystery. Wishing to obtain some information on these points, Dr. Gilbert Blane, of the Royal Society, in the latter part of the last century, wrote to his brother in India, urging him to make inquiries which might throw some light on the subject; his reply to which is to be found in the Philosophical Transactions for 1787. Mr. Blane had not, however, an opportunity of visiting in person the localities where Borax is found; on the contrary, he obtained his account at the distance of thirty days' journey from the place, and he remarks himself, that the best information

[d] Thénard's Chemistry.

he could procure on the subject was " through some of the wild and unsettled mountaineers." The following are some particulars of his account. Having an opportunity of going from Lucknow to Betowle, a distance of 200 miles to the N. E. of the former place, he there met with some men from the Borax country. They informed him that it was found in the kingdom of Jumlate, in the mountains of Thibet, thirty days' journey north of Betowle. They said that in a valley, surrounded by snowy mountains, is a lake, six miles in circumference, the water of which is so hot that the hand cannot be held in it for any time. The ground around this lake is perfectly barren, not producing even a blade of grass: after a fall of rain saline concretions are formed on the ground. Upon the setting in of the snowy season, reservoirs are made in the ground on the banks of the lake, about six inches deep, and the snow having collected in these, hot water from the lake is thrown into them, which mixing with the melted snow is partly absorbed into the earth, and partly evaporated, when the Borax is left like a crust at the bottom. The process is only carried on in winter, snow being indispensable, nor can it be made again in the same place till snow has fallen and dissolved three or four times. The water of this lake is very foul, and appears to boil up in many places. The Borax is transported on the backs of goats, and being refined by boiling and crystallization, sells for fifteen rupees the maud at Lucknow. The country produces, besides, iron, copper and sulphur.

Such is the account given by some of the natives to Mr. Blane, which at any rate sufficiently explains the impurity of the Borax obtained from this

quarter. The water of this foul boiling lake is left to evaporate without the application of any artificial heat, and without any previous deposition of its impurities, in excavations in the ground, instead of in vessels adapted for the purpose. It is not very easy to see what effect the snow can have, unless, by suddenly cooling the water, it may help to make it depose its salt in a solid form.

We have another account of the manner of collecting borax in the same volume of the Philosophical Transactions, read by Sir Joseph Banks, and written in Italian by the Father Prefect of the missions in Thibet, Joseph da Rovato. The Padre being at Patna, obtained an interview (by means of Bahadúr Sah, brother of the king of Nephāl) with a man from the borax country, who undertook to explain the matter partly in the Nephāl, and partly in the Hindostanee language. This man informed him that in the province of Marmè, twenty-eight days' journey north of Nepāl, and twenty-eight west of Lassa, the capital of Thibet, there is a valley eight miles across, containing two villages, *Scierugh* and *Kanglè*, the inhabitants of which live entirely by the sale of borax, the country being otherwise quite barren. In this valley is a lake, (Vasca di acqua,) and other smaller pools, at the bottom of which the borax forms naturally, and men entering the water feel it with their feet, forming a crust at the bottom, Four miles off, in the same valley, is a great abundance of salt. Ten days further north of Marmè is another valley called Tapré, where borax is also found. Blane writes the Indian name *Swagah*, and the Padre *Soaga*.

Since this paper was read, Professor Wilson has had the goodness to send me the following extracts on the subject, the first of which is from the travels of Messrs. Moorcroft and Trebeck, not yet published.

"One of the chief articles of transit in the trade of Ladakh is Borax, which is brought from Bhot, sometimes by the Bhotias themselves, but more commonly by the people of Lahoul, who convey it to Kulu and Chamba, where it is refined, and whence it is exported to the Panjab and Hindustan, for the use of braziers and silversmiths. It is bought in Bhot at about 120lbs. avoirdupoise for a rupee: by refining, it loses half its weight, but the remainder sells for five or six rupees. There is also a sort of smuggling-trade carried on in this article: the shepherds of these provinces receive a gratuity for pasturing the flocks of Kotock, Chamba, &c. on the borders of Lahoul, but they sometimes take half the flocks with them to Bhot for Borax, instead of leaving them to graze on the mountains, and are thus enabled to sell it at a lower price." Moorcroft and Trebeck's Travels, I. 355. See for an account of the Bhotia export of Tincal, by way of Kamaon, the Asiatic Researches, vol. XVII. p. 41.

Turner says, "Bootan, Nipal, Bengal, and Hindustan, are supplied with Tincal from Tibet. Its value is little more than that of the labour employed in digging it from the bed of a lake in which it is deposited, at the distance of about fifteen days' journey from Testoo Lomboo." Journey to Tibet, 371.

A further account is given by Mr. Saunders in the same volume, p. 406.

" The lake from whence Tincal and rock salt are collected is about fifteen days' journey from Tissoolumboo, and to the northward of it. It is encompassed on all sides by rocky hills without any brooks or rivulets near at hand, but its waters are supplied by springs, which being saltish to the taste, are not used by the natives. The Tincal is deposited, or formed in the bed of the lake, and those who go to collect it dig it up in large masses, which they afterwards break into small pieces for the convenience of carriage, exposing it to the air to dry. Although Tincal has been collected from this lake for a great length of time, the quantity is not perceptibly diminished, and as the cavities made by digging it soon wear out or fill up, it is an opinion with the people that the formation of fresh tincal is going on. They have never yet met it on dry ground or high situations, but it is found in the shallowest depths, and the borders of the lake. From the deepest parts of the same lake they bring rock-salt, which is not found in the shallows. The waters of the lake rise and fall very little: it is at least twenty miles in circumference, and is frozen over for a great part of the year."

The locality of Turner and Saunders cannot be the same as that of Moorcroft and Traill.

There is a brief statistical notice of Borax also in the Asiatic Researches, vol. XVIII. p. 234.

Borax, Tincal, (*Sansc.* Tankana,) Sohága (*Sansc.* Saubhágya) is very extensively used all over India for soldering, and as a flux for promoting the fusion of both silver and gold. It was invariably employed by the native melters in the mints, until the intro-

duction of different vessels and more powerful furnaces obviated the necessity of its use." Professor Wilson adds; "No European, as appears from the above extracts, has visited the site of the lake, or lakes, where Borax is found, and our knowledge of it is yet vague and unsatisfactory. It is said to be found in Persia also, but I do not recollect any particular account of the situation in which it is met with."

The necessity however of importing Borax from these distant parts, and in the impure state in which it is there obtained, is obviated since the discovery of the existence of Boracic acid in Tuscany.

The district in which this acid is produced in Tuscany is included in a circle of about nine miles in diameter, situated between the towns of Volterra and Massa Marittima. Within this area are eight or nine different establishments for its collection, nearly all the property of a French gentleman of the name of Larderel. The first attempt to avail themselves of Hoëffer's discovery by the extraction of this acid from the waters of the lake near Monte Rotondo, was made by the former proprietor of the land in that part, about twenty years ago. With trifling capital and little knowledge he could only prove the possibility of turning to good account this steam, which had been for ages issuing from the ground in every direction, charged with wealth, but which hitherto had served only to create a superstitious fear in the minds of the ignorant inhabitants. Few were bold enough to approach the spot where the steam rushes up with a roaring noise from crevices in the ground, enveloping every thing in thick, stinking smoke; or if they did, it was only with a

crucifix in their hand. Science and commercial enterprise were however destined to convert these objects of dread into a blessing to all the inhabitants of the deserted country in which they are situated, and to make them a mine of wealth to their proprietor.

Your approach to one of these interesting spots is announced by the appearance of a white vapour, filling generally a ravine on the slope of a hill, and concealing all other objects beneath it. It is not till you have approached to within a short distance, that you begin to distinguish houses and men, and soon you step out of your carriage in the midst of volcanoes, and find yourself enveloped in a steam of a peculiar odour, more acid than sulphureous. You see on every side steam bursting from fissures in the ground, which is hot to the feet, and pools of black, muddy water in a state of violent ebullition, whilst your ears are full of hissing and boiling sounds. Any body who has lately read Dante, cannot avoid the persuasion that he had these Lagoni in his mind when he described at the end of the 7th canto of the Inferno, the place of punishment of those whose crime had been the indulgence of angry passions.

Far murkier was the wave
Than sablest grain: and we in company
Of th' inky waters journeying by their side
Enter'd, tho' by a different track, beneath.

* * * *

The good instructor spake: "Now seest thou, son!
"The souls of those whom anger overcame!
"This too for certain know, that underneath
"The water dwells a multitude, whose sighs
"Into these bubbles make the surface heave,

" As thine eye tells thee wheresoe'er it turn.
" Fix'd in the slime, they say, 'Sad once were we,
" In the sweet air made gladsome by the sun
" Carrying a foul and lazy mist within:
" Now in these murky settlings are we sad.'"
Such dolorous strains they gurgle in their throats,
But word distinct can utter none.

Cary's translation of Dante.

The process employed for turning these issues of steam to account is as follows: Round the more considerable fissures a circular basin is dug, about four feet deep, and usually three or four yards across. These basins, which are called *lagoni*, being situated at different levels, the water of a rivulet is admitted into them, which mixing with the black mud at the bottom, is made to boil up violently by the issues of vapour within its circuit. The water is generally confined in each basin for twelve hours at a time, during which period it becomes saturated to a certain extent with acid from the steam which has passed through it. It is then drawn off from the higher basin to one beneath it, where it remains an equal length of time, till at length it reaches a building at the bottom of the hill, in which the process of evaporation is conducted. The immense profit derived from the lagoni is chiefly the consequence of a happy expedient for effecting the evaporation, which was first put in practice in 1827. Previous to this period, wood-fires were employed for this purpose, but in that year the heat of the natural steam was applied to the evaporation, which of course at once effected an immense saving of fuel, and at the same time enabled them to replace the iron, by leaden boilers. Having arrived at the building, as before mentioned, the water of the lagoni

enters a cistern, where it is allowed to repose till it has deposited the mud which it held in suspension. This silt is said to be a useful application for cutaneous diseases in animals. Having cleared itself of impurities, the water is then drawn off from the cistern into flat leaden pans, under which some of the natural steam is conducted by brick drains, about two feet under ground, and by this heat is evaporated. This process requires about sixty hours, the water passing successively from the pans at the upper extremity, into others at the centre, and from thence into others at the lower extremity of the building, by means of leaden siphons. Having arrived at a proper state of concentration, it is then conducted into wooden tubs, in which it cools for about five days, during which the crystallization of the boracic acid takes place on the sides of the tubs, and on the stick in the centre. The water which remains is then pumped off, and passes again with fresh water through the evaporating pans. The acid having been removed from the tubs is then spread on the floor of a closed chamber to dry, by the heat of the steam made to circulate beneath it. The acid thus prepared is sent in casks to Leghorn, where, by the mixture of soda with it, it is made into borax, which is thus obtained much purer than it is found in nature. As to the annual produce of these works, I have no better authority than the statement of the chief director, who informed me that about 2,000,000lbs. of boracic acid is made by Mon. Larderel in the course of the year. This is exported to all parts of the world, and sells at Leghorn for 2*l*. 8*s*. per cwt., which would make Mon. Larderel's gross income about 40,000*l*. per annum.

From this very few thousands are to be deducted for directors, workmen, buildings, carts and horses, and other necessary expenses, though all the workmen are well paid and lodged, and (by his wishes) all married men, whose families he educates. Besides carrying on the whole business on a liberal scale, so sudden a creation of wealth has had its natural effect in rendering him less careful of expense than is quite prudent; and having laid out a large sum in the purchase of a title of nobility, his equipages, houses, and fêtes to the grand duke, are in the most splendid style.

This property, rich as it already is, might, I conceive, be rendered more valuable, did not the monopoly which Mon. Larderel has secured, by purchasing all the country where this steam rises, render him indifferent to any trifling ameliorations in the very simple process which, as it is, produces such magnificent returns. The vapour which has passed through the water in the pools, and is then allowed to go off, has not evidently parted with all its acid, the remainder therefore is lost. It seems strange that some means cannot be found of obtaining the acid, which appears to be in a state of sublimation, at once from the vapour, for instance, by condensation. Many small issues of steam are at present neglected, the power of which might perhaps be very much increased by means of the boring machine. The laws which regulate the greater or less production of acid also deserve to be investigated. For instance, I was informed that dry weather, whether hot or cold, is favourable to its production. Hence the moist Scirocco, or S. W. wind is bad, and the Tramontana, or N. wind, the contrary.

Besides the steam containing boracic acid, it rises in some parts in a pure state, and might be employed for various domestic purposes, such as heating houses, cooking, washing, brewing, &c. It might also be used to ripen exotic fruits, being made to circulate in walls, and for rearing all the plants of the tropics under glass. Whether it could be employed as a mechanical power is more doubtful. The only purpose to which it is now applied, except that of evaporating the water impregnated with boracic acid, is the drying of chestnuts, which, in this country are ground, and used instead of wheat-flour. The fruit is exposed to the heat in metal or earthenware vessels, which are placed over the issues of steam. The most plentiful source of pure steam which I observed at Monte Rotondo, came out of a small cavern, beneath a ledge of limestone, on the surface of which, a portion of the steam being condensed, forms beneath a pool of naturally distilled water, much esteemed for its purity by the people of the country. On placing the ear within the mouth of the cavern, a roaring noise is heard, caused apparently by the escape of the steam through a narrow passage. This latter rock, unlike those exposed to the action of the acidulated steam, shews few signs of decomposition, and it is singular that a kind of Oscillatoria, which is also found in the Geysers of Iceland, as I am informed by Sir W. Hooker, is growing on the rock in the place where the hottest steam continually envelopes them, and thus from the peculiarity of their situation these plants seem to merit the attention of cryptogamists.

It now only remains to describe the geological formation through which these remarkable co-

lumns of steam make their passage. The principle rock which prevails at Monte Rotondo and Monte Cerboli, and indeed in a great part of Tuscany, (forming, as it were, the skeleton of the country, in the hollows of which are deposited the sub-Apennine marl and sands,) is a compact limestone, often becoming highly inclined and schistose, and called in Tuscany, Alberese. From the scarcity of organic remains in this rock, in which I never saw any, its position in the geological series has been doubted; but the general opinion seems to agree with that of Professor Savi, of Pisa, who places it at the bottom of the cretaceous group. However this be, it appears that the volcanic forces beneath this part of Italy, which have in other places heaved up serpentine through this rock, have here found a vent through it in the form of steam. This limestone is traversed at Monte Rotondo, by a hard siliceous, and quartzose rock, upon which the action of the acidulated steam is very remarkable, decomposing it so as to give it a porous, spungy appearance, and converting it into a white impalpable powder, excellently adapted for making china. A stone, if it happen to lie over a vent of this steam, usually has a thick layer of crystallized sulphur on its under side, and is rendered so fragile as to break away with the slightest effort. Small stones which have lain some time in the boiling lagoni, have an appearance of being bronzed on the surface. It would appear, from a consideration of the localities where this phenomenon is exhibited, that the steam finds less resistance in making its exit on the flanks, or towards the bottom of hills, than at their summits, to which it has a constant tendency

to approach by eating into the hill, and rising continually nearer its culminating point. There may, perhaps, be less resistance in passing more or less horizontally between the strata, than in cutting them perpendicularly. Hence it would seem that the proprietor of the higher ground has it in his power to cut off the supply from his neighbour on a lower level, if, by the boring machine for instance, he can pierce to a stream of vapour, which would then rise perpendicularly in his property. Such was the idea of the state of things suggested to my mind by some experiments which I witnessed on a small scale. By the erosion of the rocks traversed by this steam, land-slips are caused, by which the passages through which the steam previously found an exit are stopped up, and it bursts forth at one or more points where there was no appearance of it before. Within the area where this phenomenon is exhibited, are also several hot springs, particularly at Bagni à Morbo, which are doubtless connected with the same subterranean causes. In the immediate neighbourhood of the lagoni are found salt, sulphur, alabaster, gypsum, serpentine, and chalcedony, of which last the beautiful works in *pietra dura* are executed at Florence.

Near Monte Rotondo, but in a valley someway beneath Mon. Larderel's establishment, is the lake of Sasso, through the waters of which a quantity of steam rises, and from whence boracic acid was first obtained. This however is all now wasted, a dispute having been raised as to the person in whom the property, now become so valuable, vests. I mention this lake, not only on account of its interest in the history of this remarkable mineral, but also

of a curious tradition as to its origin, which was related to me by a countryman, who was my guide in this neighbourhood. I must first beg the Society not to be shocked by the introduction of our Saviour's name, as it shews the degree of historical religious instruction which these people receive.

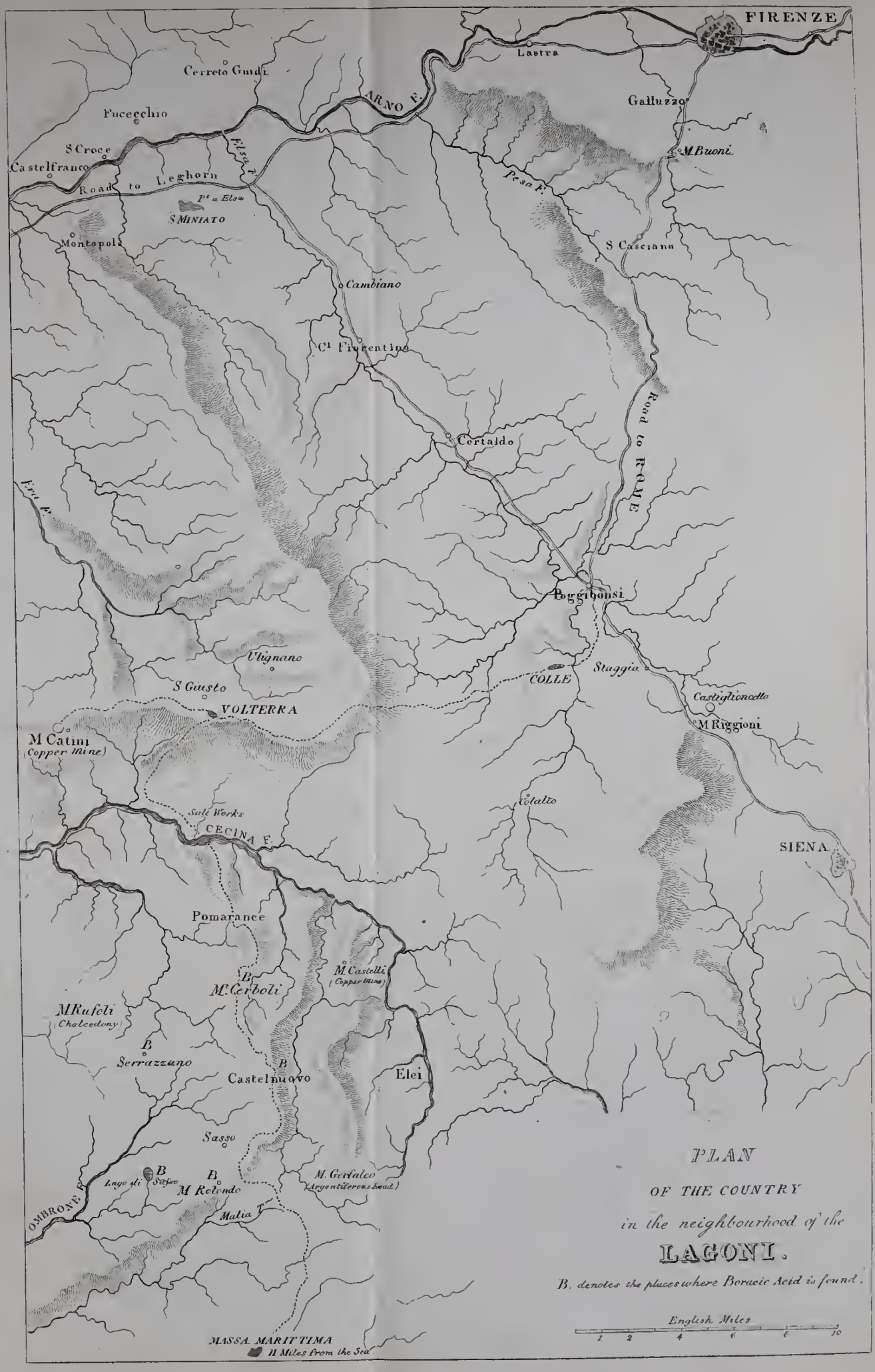
The following is an extract from my journal. "From the heights of Serrezzano you see to the right steam ascending from the lagoni of Sasso and Monte Rotondo. The sight of this eternal smoke rising from different parts of the plain below me, naturally reminded me of the striking account of the destruction of Sodom and Gomorrah; whilst thinking of which, my guide commenced the following narrative: 'In the place of that boiling lake from which rises the smoke which the signore sees down there, was once a *podere*, (i. e. a small peasant's farm.) It was the 5th of August, the festival of la Madonna della Neve, when our Saviour passed that way, and seeing the master of the house busy at work, he asked him if he were not going to mass? No, said the man, what *festa* is it to-day? It's the festival of our Lady of the Snow, answered our Lord.——Well, said the man, I've other business to-day, I can't go to mass. So when our Saviour found he could not persuade the man or his wife to go, he said, If *you* are too busy, at least let those two little boys go with me, they have nothing to keep them away. This was agreed to; so, taking the children by the hand, they departed together. They had not got far up the hill-side, when our Saviour turned round, and bid them look over the plain towards where their home had been, but it was all gone, and nothing was to be seen of all their

vineyards, olive-fields, or their house, but in their place was that boiling, smoking lake.'"

The above are a few of the more obvious remarks suggested by the sight of these remarkable localities, and which I have been induced to offer to the Society, partly because I am not aware of any description of them having been yet given in English, and partly in the hope of inducing some member, more competent than myself, to do justice to the subject, to step a few miles out of the high road to Rome, and devote a few days to their study. For this purpose a knowledge of chymistry would be perhaps as necessary as of geology, in order to observe the various sublimations and depositions which are continually going on in this natural laboratory. Indeed, I was informed that the French chymist Payen had been employed, at the express invitation of their proprietor, in collecting all the products, solid or gaseous, which he could discover in the neighbourhood of these lagoni, which he was to examine on his return to Paris; but whether his report upon them has been made public, I am not aware. At all events to any traveller, whether scientific or not, I can safely recommend a trip from Florence, to see the very interesting Etruscan museum at Volterra, whence it is a short ride to a peculiar copper-mine at Monte Catini, and another short ride to Pomerance, the residence of Mon. Larderel, and thence to Monte Cerboli, where is the largest establishment for collecting boracic acid, and the road is practicable for a carriage.

If inclined to extend his journey in the Maremma he will find it a most interesting country, containing the remains of Etruscan cities and tombs, mines of

copper, probably worked by that nation and in the middle ages; others of antimony, iron, lead, alumn, and plants and insects, which are also natives of Africa. Some very interesting works are also in progress on a great scale, for rendering the country more healthy, by filling up the pestilential marshes by means of rivers turned into them, and there allowed to deposit the abundance of silt carried down by them. Near the Pope's frontier, and from thence to Rome, are a succession of extinct volcanos which are also well deserving of investigation.


FIRENZE
Lastra
Cerreto Guidi
ARNO F.
Fucecchio
Galluzzo
S Croce
Castelfranco
Elsa R.
M Buoni
Road to Leghorn
Pesa R.
Pt a Elsa
S MINIATO
Montopoli
S Casciano
Cambiano
Ct Fiorentino
Certaldo
Road to ROME
Era R.
Poggibonsi
Ulignano
S Gusto
COLLE
Staggia
VOLTERRA
Castiglioncello
M Riggioni
M Catini
(Copper Mine)
Colalto
Salt Works
CECINA R.
SIENA
Pomarance
M Castelli
(Copper Mine)
B
M. Cerboli
M Rufoli
(Chalcedony)
B
Serrazzano
B
Castelnuovo
Elei
Sasso
B
Lago di Sasso
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M Rotondo
M. Gerfalco
(Argentiferous lead)
OMBRONE R.
Malia T.
MASSA MARITTIMA
11 Miles from the Sea
PLAN
OF THE COUNTRY
in the neighbourhood of the
LAGONI.
B. denotes the places where Boracic Acid is found.
English Miles
1 2 4 6 8 10

NOTES

ON THE

INDICA OF CTESIAS.

BY

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NOTES

ON THE

INDICA OF CTESIAS.

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IN offering to the Ashmolean Society some observations on the statements concerning India which were compiled four centuries before our era by Ctesias, the Greek physician of Artaxerxes Mnemon, it must be unnecessary to preface my remarks by any account of that author or his writings. These are subjects with which all the members are no doubt familiar; and they will also be well aware how low a character for credibility Ctesias has borne, not only with modern writers, but with those of his own country, from what may be considered almost his own age to much later periods of Greek literature. Aristotle declares he is unworthy of belief, Plutarch holds him as a mere fabler, and even the author of the Life of Apollonius treats him as "a liar of the first magnitude."

Ctesias, however, declares that he wrote nothing but what he had seen or heard; and, notwithstanding the unfavourable sentiments to which I have adverted, and in despite of Lucian's emendation of the declaration of Ctesias, making him assert that

he had written what he had "neither seen nor "heard," I confess I am disposed to believe his averment. What he saw amounts to very little, and to nothing extraordinary. What he heard is much more copious, and more wonderful; but it was very possibly communicated to him in perfect good faith by persons who had visited the countries he speaks of, but who were persons of more credulity than observation. That Ctesias has repeated their marvellous narrations, may argue ignorance and credulity in him as well as in his informants, but it does not necessarily imply deliberate falsehood or mendacious invention.

Although, however, we may acquit Ctesias, and even those who imparted to him the strange stories he has repeated, of any settled purpose to deceive, yet it seems unaccountable how such impossibilities as he has recorded could have originated, how they could have been put forth in a country so near as Persia to the India to which they were ascribed, and with which there must have been frequent intercourse, both commercial and political; and how a man of the talents of Ctesias, a scholar and a physician, and imbued with a spirit of intelligent curiosity, could have been a party to their dissemination. To determine these points satisfactorily, it would be necessary to consider the state of society at the period at which Ctesias wrote, and the progress which the Persians and Greeks had made in physical science; but this would lead us away from the object of the present inquiry, which is restricted to the specific statements that Ctesias has transmitted; and it is sufficient for our purpose to ascertain whether they have been advanced wholly with-

out foundation, or whether we may not discover in them some glimpses of the truth. That this has not already been accomplished in a satisfactory manner, need not excite any surprise; for the inquiry demands a familiar acquaintance with the varied subjects of the narrative, and with the country to which they belong; an acquaintance not within the reach of the earlier illustrators of our author, and even now but partially within our own. The India of Ctesias is but to a limited extent the India of our day. Except in a few instances, the Indus is to the southward the boundary of his information, and the regions to which he refers are those to the northward, along the upper course of the Indus, amongst the Hindu Koh and Karakoram mountains, Balkh, Bokhara, and the banks of the Oxus to the west; and to the east, Tibet, Badakhshan, Kashgar, and central Tartary to the confines of China. These countries have been hitherto but little accessible to Europeans, and we are too imperfectly acquainted with them to be able to avail ourselves fully of the means which they may possibly afford, successfully to elucidate the Indica of Ctesias.

Incomplete, however, as our materials may yet be, they are more ample than they have hitherto been. I have therefore thought it might be worth while to apply them to the illustration of the text of Ctesias, and that this Society might take some interest in the result, not only as calculated to throw some light upon the work of a classical authority, but as affording them an opportunity of contemplating some circumstances relating to India which may not heretofore have fallen under their notice.

The accounts of Ctesias, as they exist in the fragments preserved by Photius, or in the extracts from classical writers, collected by the industry and learning of modern editors and annotators, are put together in a most desultory manner, without any regard to subject or connexion. As it would be painful to follow such an unsystematic series, I have attempted to classify the different sections, and purpose to comment upon them under two principal heads: the first embracing all that Ctesias has stated regarding the country itself, and the people by whom it was inhabited; and the second comprehending his descriptions of the products of nature in the animal, vegetable, and mineral kingdoms.

INDIA AND ITS INHABITANTS.

CAP. I. Strabo XV.

"India," according to Ctesias, "was as extensive "as the rest of Asia; the people as numerous as all "the rest of mankind: and there was no nation be-"yond them, or more to the east."

The correctness of these statements is to be estimated with reference to the prevailing notions of the extent and population of the globe in the days of the writer. At a much later period, when combating the exaggerations of Onesicritus, Nearchus, Deimachus, and Megasthenes, as well as those of Ctesias, Strabo concurred with Eratosthenes in extending the eastern limits of India, to the ocean [a], and assigning it a breadth of 16,000 stadia from north to south, and a length of 19,000 from east to west, whilst the whole breadth of the habitable world was not above 30,000, and the whole length 70,000 stadia, making India therefore more than half the width, and nearly

[a] Strabo, lib. i. xv.

one third of the length of the habitable globe. Agreeably to the notions of the Hindus, India would be still more extensive; for Aryavartta, the holy land, the country of the Hindus, is considered, in the Puranas, as bounded both upon the east and the west by the sea. The latter limit would carry India to the Mediterranean; and traces of this notion, although no longer entertained when Ctesias lived, may be discovered in classical as well as Indian authorities; for there were Indi in Colchis, in Mesopotamia, on the Tigris, and even in Thrace, according to ancient writers quoted by Bryant[b]. He therefore concludes that Chaldea was the parent country of the Hindus. "The arts and sciences," he says, "imported into India came from the Cuthites of "Chaldea:" and again, "One of the most consider-"able colonies that went from Babylonia was that "of the Indi, or Sindi, who settled between the "Indus and the Ganges: a large body of them "passed to the north, and thence extended them-"selves eastward quite to the ocean[c]." And this theory has recently received the countenance of an eminent oriental scholar, Col. Vans Kennedy, who traces the origin of the Sanscrit language to the country about Babylon[d]. It seems probable therefore, that ancient tradition, as well as imperfect geographical knowledge, had diffused amongst the Greeks indistinct notions of the vast extent of the Indian world, at a period prior to the more scientific cultivation of geography by the Alexandrian school,

[b] Analysis of Ancient Mythology, vol. iv. p. 245, 252.

[c] Ibid. vol. v. p. 226.

[d] Researches into the Origin and Affinity of the principal Languages of Asia and Europe, p. 221.

which would justify the statements of our author. Of the western limits of India, however, the times of Ctesias were able to form some tolerably correct idea; but to the east the boundary was still unknown; and even in the days of Pausanias, the country of the Seres, or China was supposed to be an island in the Erythræan sea[e], whilst Strabo[f] makes the prolongation of the chain of Taurus or the Himalaya, extending to the Eastern sea, the boundary of India. This sea, it is true, M. Gosselin[g] supposes to have been the bay of Bengal; but this is rather incompatible with his notion, that the Thinæ of Strabo, who occupied the extreme boundary, were the people of the Tenasserim coast, as that would then be the boundary of the ocean, instead of being bounded by it. Nor can it be supposed that the Indians themselves intended by their Eastern ocean the bay of Bengal; and we must therefore conclude, that it meant the China sea, or sea of Japan, and that China was included in the denomination, India, although its precise situation and extent may not have been accurately known.

Without, however, comprising China within the limits of India, there is no doubt that the latter country was more extensive even before the invasion of Alexander than it was subsequently, including Ariana, Arachosia, Margiana, Bactria, and even Sogdiana, and part of the Sacha regio, which were separated from it by the Macedonian conquests. In later times, the pressure of the Mongol and Turk tribes on the north, and the advance of the Mohammedans from the west, have still further contracted its boun-

[e] Bryant, v. 227. [f] Lib. xv.

[g] Géographie des Grecs. Mémoires de l'Académie, t. xlix.

daries, and detached Kandahar and Kabul from India, although they, as well as Bahlika, or Balkh, are enumerated amongst Indian countries in the Puranas; and the Sakas, the Σακαι, or Sacæ, are in the same works, and in the laws of Menu[h], described as Indians originally of the Kshetriya or military tribe, but who were deprived of caste by Sagara, a king of India, as a punishment for taking part in a successful insurrection against his father[i]. We may still discover in those countries names of places and of people, and traces of manners, evidently of Indian origin.

At the same time that India was more extensive in ancient than in modern times, it seems to have been more populous, as far it was known. Besides the numerous armies brought into the field against Alexander, by princes ruling over very limited territories, it is said by Strabo that the Macedonians reduced 5000 considerable cities[k], and that Eucratides the Bactrian prince, reigned over 1000 in a region where scarcely a dozen places, that deserve the name of towns, are now to be met with, and where there are not above three or four cities, as Cabul, Peshawar, Lahore and Amritsar, that are of any consideration. The depopulation of Afghanistan and the Punjab is in a great degree owing to the state of anarchy in which they were involved upon the downfall of the Mogul monarchy, and in which the former at least is still plunged, whilst in the latter it has been only recently suspended by the talents of Ranjit Sinh, and is likely to recur upon his death. Similar causes have very much reduced the population of very extensive portions of India in

[h] Institutes of Menu, x. 43, 44.

[i] Vishnu Purána, b. 4. c. 3.

[k] Lib. xv.

other directions, and its surface is not without a due proportion of tracts of desert and wilderness, mountain and waste, where nature is inexorably opposed to the multiplication of human beings. Nevertheless, the average population of the whole country is still considerable. The latest accounts, and which, though necessarily imperfect, are best entitled to confidence, estimate the superficial area of India at above a million of square miles, with a population of 120 millions, or 120 to each square mile[1]; an average exceeding that of England and Wales a century ago. Where circumstances are favourable to increase, the population of India presents a ratio of the highest magnitude, and in the province of Burdwan is 600 to a square mile[m], although there is not a single town of any note in the district. Although therefore the amount assigned to the population of India by our author may not have been founded on very good authority, it was not very extravagant with reference to the population of those countries which formed the ancient world.

The only river of importance with which the Persians were likely to have been well acquainted was the Indus, and it does not appear that their know-
1. ledge of it was very correct. Ctesias says it was 40 stadia broad in its narrowest, and 200 in its widest part. In citing the same passage, however, Arrian reads 100 stadia for the greatest breadth[n].

It is only very recently that we have become acquainted accurately with the course and extent of

[1] Hamilton, Description of Hindostan; Journal of the Asiatic Society, Calcutta; vol. ii. 488.

[m] Asiatic Researches; xii. 551.

[n] Arrian, lib. v. de Exped. Alex.

the Indus, by the travels and surveys of Lieut. Burnes [o], and have acquired the right as well as the ability to question the measurements of our author. At Attok, where the river is most usually crossed now, as it was in the days of the Macedonians, the breadth is but about 260 yards, in the month of June, when it is fullest; in March, it is not above 120. The greater of these two is very inferior to the 40 stadia of Ctesias, even if we were to adopt the proportion assigned to the stadium of this period by M. Gosselin; for at the rate of 1100 stadia to a degree of latitude, we have about 16 stadia to a mile, and consequently 40 stadia are equivalent to about $2\frac{1}{2}$ miles. If we adhere, however, to the Olympic stade, it is above four miles and a half. At the same time we may make some excuse for the Greek writer, when we find a credible English traveller, Mr. Forster [p], who actually crossed the Indus above Attok, asserting that it was from three quarters of a mile to a mile in breadth, where not interrupted by islands. Some way below Attok, Messrs. Moorcroft and Trebeck found the river divided into two branches by a considerable island, and the nearest branch, although not above 100 yards or so in breadth, ran in a sandy bed that was 600 yards broad: when the whole bed is filled, therefore, the expanse of the river must be here at least half a mile. Even at Tatta, however, only 100 miles from the sea, the river is not above 700 yards across, and the greatest width which it ever attains in a single channel is not above 1000. There

[o] Travels into Bokhara, &c.; Voyage up the Indus, and Memoir.

[p] Journey over land from Bengal to England in 1782, &c.

is one exception in the Koree, the most eastern limit of the Delta of the Indus, which below Luckput, suddenly opens like a funnel to a breadth of seven miles, and increases until one bank is no longer discernible from the opposite one. It is not likely, however, that this branch was known to Ctesias, and his measurement cannot apply to the whole of the Delta, for that, according to Arrian, occupied 1800 stadia.

V. The Indian sea, it is said, is not less extensive than the Grecian sea. The Erythræan sea in the extent attributed to it subsequently to the days of Ctesias, appears to have comprised, along with the Red sea, that part of the Indian ocean between the straits of Babelmandel and the Malabar coast. The Indian sea of Ctesias may have been only the part between the Persian gulf and the coast of Malabar, and in that case might admit of some comparison with the Ægean. The water, he adds, is so warm for the depth of four fingers, that the fish cannot come to the surface. From experiments made by Messrs. G. and J. Prinsep, it appears that the mean temperature of the sea in the bay of Bengal exceeds that of the Atlantic, being in August, when it is probably at its highest, 81° 75′[q]; a temperature not sufficiently high to boil fish.

I. Of the climate of India it is said that "there is
" no rain, and that the lands are watered by the in-
VIII. " undations of the rivers; that there is neither thun-
" der nor lightning, but frequent gales and hurri-
" canes. The heat is so great, that in summer many
" are suffocated by it, and the sun seems to be twice
" as large as in other parts of the world. The rising

[q] As. Res. xv. App. xvii.

" sun diffuses coolness, and for thirty-five days in the " year, at a certain place which is sacred to the sun " and moon, situated in an almost inaccessible tract, " at a distance of fifteen days' journey from the moun- " tains that yield the sardonyx, the sun restrains his " rays on purpose that pilgrims coming to an annual " festival held there may not be burnt alive."

In these accounts there is more of error than of truth, but they are not wholly without foundation. The countries along the Indus, although not absolutely without storms and rain, are especially subject to strong and dry gusts of wind, blowing up the sandy soil into hills, and the fertility of many parts of India depends much more upon irrigation and inundations than upon rain. A tract of between four and five hundred miles in length, and about two hundred in breadth, on the east of the valley of the Indus, is known to the Hindus as the *maru desa* [r], the dry country or desert; being for the most part an arid waste, thinly sprinkled with spots of cultivation, the miserable inhabitants of which, according to Col. Tod [s], calculate upon a partial famine every third year, and suffer occasionally under such an infliction three or four years consecutively. Similar sandy and desert tracts abound more to the north and north-west, dividing Bokhara from the Oxus and from the Caspian, and compared with which the Indian deserts of Jeselmer and Parkur sink into insignificance [t]. Even in more favoured tracts, or in the cultivated portions of the Punjab, Balkh, and Bokhara [u], productiveness depends more upon the supply of water from rivers

[r] Tod's Annals and Antiquities of Rajasthan, vol. ii. 289.
[s] Page 327. [t] Burnes, ii. 11. [u] Burnes, ii. 158.

and canals than from rain. Although it rains in the spring in Bokhara, yet the climate is arid, and the country would be uninhabitable, were it not for its rivers. In Shehr Sabz, where the canals cease, a sterile desert succeeds, and in Balkh the canals intersect the whole country.

With regard to the size of the sun, it is only said that it seems to be double its ordinary size; and it would have required good eyes to have accurately measured its dimensions in an Indian sky. It may however be observed, that in the regions of the East the minor planets shine at the dry season with great brilliance, in consequence of the clearness of the atmosphere, and may be thought to look larger and nearer to the earth than in more western climes. It is also true, that in those parts of India where the hot winds blow, the coolest hours of the twenty-four are those immediately preceding and following sunrise. It is much cooler then, for a brief period, than at midnight. The annual intermission of the sun's heat rather exceeds the period which Ctesias has assigned to it: and whatever may be thought of the cause to which it is ascribed, there are various places in India, sacred to both the sun and the moon, which were in former times objects of pilgrimage, although not so at present. Several such places are mentioned in the lists of Tirthas, or holy shrines, some of which are evidently situated in the north-west of India, although the situation is not distinctly specified. Amongst others in the Mahábhárata[y], we have the "abode of Aditya of accu- "mulated radiance, renowned in the three worlds,

[y] Mahábhárata, Vana Parvan, vol. i. p. 529.

" where he who bathes and worships the sun se-
" cures for himself and his family admission to the
" solar sphere;" and adjacent to it, " the holy shrine
" of Soma (the moon), bathing and worshipping at
" which elevates most assuredly a man to the moon."
Although, however, there is no longer any shrine dedicated to the sun, nor any worship addressed particularly to any of the planets, yet it is admitted that all Sundays are sacred to the sun, as the name in Sanscrit, Aditya vára (आदित्यवार), as well as in other languages, imports; and that the Sundays in the month of Mágha (January) are so in an especial manner. The sun's entrance into the sign Capricornus, the Makara Sankranti, the winter solstice, is also still a festival; and people go to different holy places, as the mouth of the Ganges, to bathe and worship. It is clear, therefore, that in the passage under remark allusion is made to a season, and to a form of worship, which no doubt was popular in ancient times, and which is still, to a certain extent, observed by the Hindus.

Some of the most marvellous narrations of Ctesias relate to races of people by whom he says India is inhabited; yet even in them there appears to be a slight tincture of truth, or at least some foundation for the strange details that are given.

" The people," he says, " are black by nature, not IX.
" by the action of the sun. A few amongst them are
" very fair (λευκοτάτοι):" and he mentions having seen two women and five men of such a complexion. There are Albinos in every part of India, the whole of whose skin is, as Dr. Ainslie[z] describes it, like that of a dead European who has not been much

[z] Materia Medica of Hindostan. Madras, p. 300.

exposed to the sun. And Dubois[a] observes, that it is no uncommon thing to meet with a class of individuals much whiter than Europeans: they have light hair and weak eyes, but can see well in the dark. It might have been to some such objects that Ctesias refers: but if that was not the case, it is very possible that he might have met with Indians, whom, as contrasted with the swarthy complexion of the Persians, and of the Greeks themselves, he might have considered fair. Many of the people of the west and north of India, and of Turkestan, are not darker than the nations of the south of Europe, with a warmth of tint and a ruddiness of complexion that is not always found amongst the latter.

XIV. Of the manners and customs of the Indians, their justice, loyalty, and contempt of death, we have only the titles of the chapters. Devotedness to their employers and contempt of death are still their characteristics; and some remarkable instances of both have very lately occurred. The kings of the Indians, according to him, are not allowed to be intoxicated[b]. And drinking is one of the vices which Manu enjoins a king most carefully to shun: "With "extreme care let him shun eighteen vices; ten "proceeding from love of pleasure, eight springing "from wrath, and all ending in misery. Drinking, "dicing, women, and hunting, let a king consider "as the four most pernicious of those vices which "love of pleasure occasions[c]."

[a] Description of the People of India, by the Abbé Dubois, p. 199.

[b] Apud Athenæum, lib. x.

[c] Manu, vii. v. 45—50. Sir Wm. Jones's translation.

"None of the Indians," he says, "ever suffer head- XV.
"ache or tooth-ache, or maladies of the eyes, or have
"pimples about the mouth. They live to the age of
"120 or 130, and some even to 200."

The simple diet of the people of India preserves them very generally from affections connected with disorders of the stomach; and they are remarkable for good teeth. Diseases of the eyes, however, are far from uncommon; and the duration of life is greatly exaggerated. Longevity, however, in the natives of the north-western provinces, is not rare; and the standard authorities of the Hindus regard a century as the natural boundary of human life; after which, voluntary death is not only excusable, but becoming: as it is said of king Sudraka, "Hav-
"ing attained the age of one hundred years and ten
"days, he entered the fire[d]." The prayer to be addressed by its parent to a newly-born infant also says, "Thou art born of my body, my child, to live
"for a hundred years[e]."

We next come to races of a different description, but who, amidst the cloud of fable which invests them, are very probably of Indian origin, either through the medium of fact or fiction.

"In central India," it is asserted, "a black people XI.
"of pigmies reside, speaking the same language as
"the other Indians, but of dwarfish stature, some of
"them being not above a cubit and a half, and the
"tallest not exceeding two cubits in stature. The
"hair of their heads descends below their knees, and
"their beards are longer than those of other men,
"so that they use no garments, as they can wrap

[d] Hindu Theatre, i. 15. [e] Bagbhatta Uttara Tantra.

" themselves up entirely in their hair. They are " flat-nosed and ill-favoured, and are distinguished " by the disproportionate size of the sexual organ, " which descends to the ancles. The king of the " Indians has 3000 of these pigmies in his service, " as they are expert archers. They are an upright " race in their conduct, and observe the same laws " as the other Indians."

The belief that a people of Lilliputians existed, appears to have been very general amongst the ancients, and was very widely disseminated before the times of Ctesias. Various situations were assigned to them, and they were supposed to inhabit Thrace, Egypt, and Ethiopia[f], as well as India. Another circumstance, as old as Homer, is not mentioned by Ctesias, their being that " small infantry warred on " by cranes," or their combats with large partridges, which Megasthenes describes, or their riding upon partridges, or upon diminutive sheep and goats to the encounter, that others speak of. In fact, therefore, Ctesias deals less in the marvellous here than other authors. That the origin of this belief is to be traced partly to the real occurrence of dwarfs, and partly to the mistaking of monkeys for men, is exceedingly probable. Domitian evidently conceived the former notion when he set dwarfs to fight, and turned in cranes upon them[g]; and the soldiers of Alexander, it is recorded, actually charged a troop of monkeys, taking them for pigmy foes[h].

[f] Iliad, b. 6. Aristot. Histor. Anim. viii. Juvenal, xiii. 167. Strabo, xv. Gerania in Thrace, an ancient city of the pigmies, Pliny, iv. 18: also viii. 2. Athen. ix.

[g] Statius, Sylv. i. 6. 57. [h] Strabo, xv.

Dr. Tyson [i] identifies the pigmy and the Chimpansè, or large African monkey, but the majority of writers lean to the opinion that the prototype of the pigmy is to be sought for in the human race. Buffon thinks it probable that the fable of the pigmies contained some truth. Aristotle believed that what was related of them was fact, not fiction; and the Abbé Banier [k] concludes that the poets by whom the story was first narrated gave it an air of improbability by their exaggerations. "En un mot," he observes, "ils ont fait les géants trop grands et les pygmées "trop petits." Accordingly, the pigmy people are considered by Olaus Magnus to be the Samoyedes and Laplanders. Some German writers have placed them in the mines of Lusatia and Thuringia, in one of which Thurneisser has asserted [l] that the dead body of a man, two feet three inches long, was actually found. The object of the Abbé Banier's dissertation is to claim for the Pechini of Ptolemy, a diminutive people of Ethiopia, the honour of being the pigmies of Homer. Buffon [m] has given an account of a people of white dwarfs in the centre of Madagascar called Quimos, or Kimos, of whom one individual, a woman of mature years, who had been seen by the narrator, measured but three feet and seven or eight inches; and he also mentions a notice of a people in America, in Tucuman, bordering upon the Patagonians, some of whom had been brought by the Spaniards to Europe, whose height was under three feet. To these may be added the Papuas, or

i Essay on Pigmies and Satyrs.

k Mémoires de l'Académie des Inscriptions, v. 101.

l Mémoires, &c. v. 105.

m Histoire Naturelle, v. xi. 288.

negroes of the Eastern islands, amongst whom a stature of four feet nine inches is that of a full grown male [n]. Whatever may be the value of these testimonies in favour of the ancient notion, as it regarded pigmy races in other parts of the world, it is foreign to our purpose to consider. It only concerns us to inquire what may be met with in India likely to elucidate the history of the pigmies in that country.

Dwarfs, some of whom are not much above three feet high, are not at all rare in India, and there, as well as in Europe in the middle ages, they formed part of a great man's retinue, at least in former times. Thus in the Ratnavali, when a monkey having broke loose alarms the household, "the dwarf," it is said, "creeps into the jacket of the chamberlain [o]:" and in the Viddha Sálábhanjiká [p], where a domestic picture of a prince, his queen, and attendants is described, the dwarf and the monkey are amongst the portraits. A dwarf, indeed, plays an important part in Hindu mythology, being the character assumed by Vishnu in one of his avatáras, or descents upon earth; and in the same mythology we have a still more diminutive race, the Balakhilyas, or Balikhilyas, pigmy saints and sages not bigger than the thumb, the sons of one of the patriarchs, Kratu, to the number of 60,000, attendants upon the chariot of the sun, and drinking his beams, or seated at the foot, or hanging on the branches of the Kalpa druma, or tree of heaven, immersed in contemplative devotion, or engaged in sacrificial rites;

[n] Crawfurd. Indian Archipelago, vol. i.

[o] Hindu Theatre, 2. [p] Ibid. 2.

and " weak masters though they be," endowed with super-human faculties: they are often mentioned in the Puránas [q], and in the Mahábhárat a story is related of Indra, the king of the gods, having given them offence, in consequence of which he was nearly deposed from his high estate. The occasion is thus " related: Indra and the pigmies having been directed " by the patriarch Kasyapa to bring fuel for a sacri- " ficial fire, Indra performed his task readily, but he " was amused at beholding his companions, a num- " ber of grave, half-starved looking creatures of the " height of the thumb, labouring under the burden " of a single Palása stick, and struggling through " a pool of water collected in the impression made " by the foot of a cow. He went to their aid, and " lifted them and their load out of the puddle, but " in so doing he laughed, and they were grievously " displeased [r]."

It is not impossible, however, that some of the notions relating to the Indian pigmies might have been gathered from Indian architecture, in which it is very common to see dwarfish figures of grotesque visage and uncouth forms, and with gross exaggerations of some of their members sculptured either in relief, or as statues, representing attendants upon the divinities, dwarapalas, or door-keepers, and religious ascetics. Some of the latter also, even in their living condition, the gymnosophists of ancient, and the Sanyásis of more modern times, black, ugly, and emaciated, and having no other vesture than overgrown beards and hair, might have furnished some of the features of our author's description.

[q] Vayu Pur. c. 29. Kurma P. Vishnu P. b. iii. &c.

[r] Mahabharata. Adi Parvan. p. 53.

There is yet another and very probable source from which some of the circumstances may have originated, and the pigmies of Ctesias *in the middle of India* may have been suggested by the Bhils, Gonds, Koles, and other tribes, who inhabit the almost inaccessible hills and impenetrable forests of the different branches of the Vindhya mountains, extending across central India from Bengal and the Ganges to the gulf of Cambay and the coast of Malabar. These people average much less than the middle stature; they are of a very black complexion and uncouth appearance; they commonly go naked, or very nearly so, and have sometimes long shaggy beards and hair: they are all expert archers. The progenitor of these races is fabled in Hindu legend to have sprung from the left thigh of Vena, an impious raja, who had been put to death by certain holy sages. They then set to work to knead and rub his limbs, in order to provide a successor, and the first product, or his impersonated iniquity, was this ancestor of the barbarian denizens of the mountain and forest. After describing the proceedings of the rishis, or sages, the Bhágavata Purána continues: "Then arose a person of dwarfish stature and di-
"minutive limbs, of a complexion as black as a crow,
"with short arms and projecting jaw, stumpy feet,
"a flat nose, red eyes, and copper-coloured hair.
"He was called Nisháda, and was the ancestor of
"the inhabitants of the forest and the mountain."
The Padma Purána[s] adds, "that he was of hideous
"aspect and limited understanding, and was armed
"with a bow and arrows, and that he was the

[s] B. iv. 14.

" progenitor of the Chándálas (or outcastes) and " Nishádas (or foresters), races addicted to vicious " practices, and devoid of all law, civil or religious." The Mahábhárata has similar accounts of the population of Gondwana. Hamilton[t] remarks, " the coun- " try of the native Gonds remains for the most part " a primæval wilderness, its human inhabitants being " scarcely superior to the brutes, with which they " live intermixed." Malcolm[u] terms the Bhils " a " diminutive and wretched-looking race:" they are professed robbers and thieves, armed with bows and arrows. In 1831 some predatory incursions of the Lurka koles, on the western frontier of Bengal, rendered it necessary to send troops into their thickets, and they were found to be a short, black, ugly people, scarcely human in their appearance, but skilful archers. The hill-people of Rajamahal whom I have seen are much superior to the other mountain tribes, but few of them attain the height of five feet, and they are very black, with thick lips and flat noses. These races were much more widely spread over India in former times, especially in the central provinces, of which they appear to have been the earliest known, if not the aboriginal inhabitants. Their employment by the king of the Indians, of which Ctesias speaks, is a characteristic which they have long retained. They are introduced constantly into plays and poems as the guards and personal attendants of princes. In the Vikrama and Urvasi[v], Pururavas enters attended by a védhaka, a hunter or forester, the vedda of the penin-

[t] Description of Hindostan, 2. 6.

[u] Account of Central India. [v] Hindu Theatre, i. 260.

sula, and weddah of Ceylon; and in the Retnavali [x] the guards of the inner courts of the palace are kirátas, or woodsmen. In Col. Tod's Rajputana, the Meenas, a tribe of foresters, are described as retained in the service of the rajas of Delhi and Udayapur; and it appears that men of this tribe, attached to the palace of Jaypur, have been the chief agents in a late attack upon the British Resident, and the murder of a young civilian by whom he was accompanied. A similar policy has been adopted even by the British government, and the hill-men of Bhagalpur and the Bhils of Kandesh have been embodied as a local militia; the dwarf, if not the pigmy bow-men of the king of the Indians.

Of another race of Indians particularized by Ctesias we might reasonably despair of discovering any existing prototype; and yet, omitting what is hopelessly fabulous, it may not be impossible to conjecture an origin even for the Kalystrii, or Kuno-
XX. kephali, the dog-headed people [y]. "These are said to "inhabit the mountains that extend to the Indus to "the number of 120,000: they have the heads of "dogs, with large teeth and sharp claws, and their "only language is a sort of bark. They are said to "be very honest, and to maintain a commercial inter-"course with other Indians who understand their "meaning partly by their bark, and partly by signs. "They are clothed in the skins of wild animals, and
XXII. "feed upon their raw flesh. It is stated in another "passage, that they bake it in the sun. They follow "no occupation, but live by the chase, and rarely fail

[x] Hindu Theatre, 2.

[y] Ælian. iv. 46. Plin. vii. 2. Diod. i. 3. Philos. 217.

" of their prey, as they are sure archers, and very
" swift of foot. They rear sheep, goats, and asses,
" and they drink ewe's milk and curds. They feed
" also on the fruit of the Siptakora, which they dry
" like raisins, and send a quantity of it annually to
" the king of the Indians packed in baskets which
" they fabricate, along with a quantity of the flowers
" yielding a purple dye, of an insect whence a red
" dye is extracted, and of amber, and these are floated
" on rafts down the river. They barter the same
" articles, and swords, bows, and arrows of their own
" manufacture for bread, meal, and cotton garments.
" Their situation amongst lofty mountains makes
" them invincible: the king supplies them every fifth
" year with 300 bows and as many darts, 120 shields,
" and 50,000 swords. They have no houses, but re-
" side in caves. The men never wash any part of
" their persons, and the women only once a month,
" but both sexes smear themselves with oil thrice
" a month, wiping it off with skins. The wealthy
" wear cotton garments, but the greater number, both
" men and women, are dressed in skins, the thinnest
" procurable from which the hair has been removed.
" He is the most opulent who has most sheep. Both
" men and women have tails like dogs, but longer
" and more hairy. It is amongst these people espe-
" cially that extreme longevity is said to prevail.

" Beyond these, and nearer to the sources of the XXIV.
" river, are others who are very black, and neither
" eat corn nor drink water, but rear flocks of sheep,
" goats, and oxen, and live entirely upon their milk.
" It is said that they void no ordure, being born with-
" out any aperture for that purpose, and that the ex-
" crementitious portion of their food passes off either

" by the urine, or is ejected from the stomach by the
" emetic properties of a sweet root which they mix
" with their milk at noon and in the evening. At
" the latter season it operates as an emetic, at the
" former, it prevents the milk from curdling in the
" stomach.

XXVI. " In the mountains whence comes the Indian reed,
" there are not fewer than 30,000 people whose women
" bear but once in their lives; the children are born
" with teeth, and the hair of the head and eyebrows
" is grey at birth, but becomes black from thirty to
" sixty. These people have eight fingers on each
" hand, and as many toes on each foot. They are
" very warlike, and the king has in his service 5000
" of them as archers, besides spearmen. Their ears
" are said to be so large as to cover their shoulders
" and arms as low as the elbows.

XV. " Of the Seres, and the remoter Indians, it is said
" that they are of gigantic stature, some of them
" being thirteen cubits high. Men with tails, like
" satyrs, are also reported to exist in the interior of
" some island in the ocean.

" Another race of Indians, the Cynomolgi, are said
" by Ælian [y], on the authority of Ctesias, to rear a
" large breed of dogs, in order to protect themselves
" against the periodical incursions of wild cattle, who
" during the latter part of the summer are driven
" mad by the stings of bees and wasps. The dogs
" alone are able to keep them off, killing many of
" them, whose flesh is partly eaten by their masters.
" At other seasons these people hunt other wild ani-
" mals by the aid of their dogs, and also drink the

[y] Ælian, xvi. 31.

" milk of the latter." According to Julius Pollux, the Cynomolgi were the dogs, not their masters. Passages in Pliny[z], apparently derived from Ctesias, notice other monstrous people, or the Monosceli, who, although having but one leg, are wonderful leapers. The Skiopodæ, whose feet are so broad, that when the person lies on the ground, and elevates his leg, his foot answers the purpose of a parasol. And a third race, who have no necks, and carry their eyes in their shoulders.

In these accounts there are of course many absurdities which it would be in vain to attempt to explain, and all that can be said in behalf of Ctesias is, that he is kept in countenance by his countrymen, of whom Strabo[a] remarks, that in general those who have written concerning India are liars, especially Deimachus, Megasthenes, Onesicritus, Nearchus, and others of the same stamp. Even Herodotus is not free from incredible fictions, but Megasthenes and Deimachus seem especially to have been authorities for such marvels as men wrapped up in their ears, destitute of mouths and noses, one-eyed, long-legged, and having the fingers bent backwards, satyrs with square heads, serpents swallowing oxen, horns and all, pigmies, and gold-making ants. Amidst these extravagances, however, there are some vestiges of fact, and of the incredible parts it may be suspected that many of them have at least a local propriety and are of Indian origin, the inventions of Hindu superstition having been mistaken for truths by the credulous ignorance of the Grecian ambassadors.

[z] vii. 2. [a] Lib. ii. and xv.

All modern travellers in the countries within or to the north of the Himalayan mountains, to which the older stories seem chiefly to relate, agree in representing the people as a remarkably indolent and dirty race. The men leave to the women the labours of the field, and remain idling at home; and both sexes [b] exhibit a marked aversion to the use of water in ablutions of any kind, and substituting unctions of grease or oil. They are clothed for the most part in skins, with the hair inwards; whence perhaps the notion that it was removed. In warm weather, those who can afford it dress in cotton chintzes, manufactured in the plains, and procured by barter. They have little agriculture, and subsist, in a great measure, upon the produce of their flocks and herds, especially in the form of milk and butter. The use of tea very generally prevails; and this is perhaps the herb, rather than the root, which qualifies the milk, and prevents its coagulation, as well as occasionally relieves the stomach of its contents. The Bhotias and Tibetans exchange for cotton manufactures, and for rice and wheat, their wool, their cattle, and their dried fruits; and the intercourse with the people of the plains is carried on to a great extent by signs, as they speak languages unknown to their more southern neighbours. In the present day, they generally reside in log houses, or huts; but the mountains are in many places pierced with caves, which have apparently been the dwellings of a troglodyte population. At Bamian, for example, Lieut. Burnes describes the hill as quite honeycombed with excavations; and

[b] See the Travels, recently published, of Captains Munday, Archer, and Skinner.

states that the caves altogether form an immense city.

Even their having the appendage of a tail appears to admit of explanation, if the same costume which prevails in the present day existed in the days of Ctesias; and fashion in these regions is not entitled to the character of changeableness. Most of the hill tribes, both men and women, wear their hair plaited behind into one long tress; and this being elongated by worsted twist and tassels descends half way down the thigh, or even lower, suggesting not unnaturally the notion of a dog's tail. A remarkable illustration of the insular satyrs of our author is of modern occurrence. It is not a century since that a lieutenant of a Swedish vessel asserted of the people of the Nicobar islands, that they had tails like cats, which they moved in the same manner. Linnæus vouched for the narrator's honesty, and Lord Monboddo [c] exulted in his evidence as decisive of the question. The mystery is thus solved by Mr. Fontana, who, describing the people of the Nicobars, observes of their dress: "A long narrow cloth, made of the bark of "a tree, round their waist, *with one extremity hang-* "*ing down behind,* is all their dress [d]." Lieutenant Keoping saw the people only from the ship; and the blunder was pardonable in a person impressed probably by the previous assertions of Careri and Struys, Marco Polo and Ptolemy [e], with a belief that men with tails had a real existence.

[c] Origin of Language, part I. b. ii. c. 3; and Ancient Metaphysics, iii. 250.

[d] Asiatic Researches, iii. 151.

[e] Buffon, Hist. Natur. de l'Homme, vol. v. p. 45.

The dog's head appears to have not improbably originated in a verbal blunder. Kalystrii is given as the native name, meaning in the Indian language, according to Ctesias, κυνοκεφαλοι; and the question is, how far he or his informant have accurately written or explained the word. Some distinguished scholars and Orientalists, as Reland in his Miscellaneous Dissertations[f], and Tychsen in the Appendix to the second volume of Heeren's Historical Researches[g], have expressed an opinion, that all the foreign words which occur in Ctesias are not Indian, but Persian. That one or two are Persian may be admitted; but there is no reason to question the Indian origin of several of them: and the attempts of the writers in question to assign a Persian etymology to the greater number have been exceedingly unfortunate. The word *kalystrii* is an instance. Reland would derive it from *kalleh shikari*, كلّه شكاري, which, he says, means "caput cani- "num unde contracte Kaliskaroi scripsit Ctesias et "per incuriam librariorum Kalustrioi." But even if his gratuitous correction of the reading were admissible, his etymology is not; for *kalleh* means rather the crown of the head, than the head: and *shikari* means, *hunter*, *hunting*, any thing belonging to the chase, not a dog in particular. Tychsen proposes either *kelek-sir*, كلك سر, *wolf-headed;* or *kalus*, كالوس, *foolish*, *stupid;* in the superlative form kalusterin, كالوستريين, *very foolish;* converting *dog-head* into *block-head*. He is avowedly dissatisfied with either of these conjectures, and they

[f] Dissert. de veteri lingua Indica, i. 209.

[g] Historical Researches by Heeren, ii. 376.

are by no means satisfactory. The ingenuity of Col. Vans Kennedy [h] has supplied a much more probable origin in the Sanscrit *kála-vastri*, easily convertible into *kalustri*, as *v* and *u* are interchangeable letters. The sense of the compound, it is true, is not "having the head of a dog," but "having black "raiment;" and this would be fatal to the identification, if the interpretation of Ctesias were to be relied upon. There is, however, in favour of the affinity an argument of more weight, that Col. Vans Kennedy has not adverted to it, and by which therefore he was not previously biassed in proposing the Sanscrit compound. This is the existence of a people, inhabiting a mountainous district in the direction to which Ctesias refers, who have been known certainly for five centuries by the term in question. These are the people denominated by Mohammedan writers, and by the people surrounding them, the Siah-posh Kafirs, *the black-vestured infidels*. At the end of the 14th century [i] they provoked the wrath of Tamerlane, on his way to invade Hindustan, and were thence brought to the knowledge of the Persian historians. They are described as a brave though barbarous people, speaking a language peculiar to themselves, and occupying narrow valleys, amidst lofty and almost inaccessible mountains. Although unable to contend with the overwhelming power of the Tartar monarch, they were not reduced without difficulty and loss. At a later period the Siah-posh were said by Baber and Abulfazl to be the descendants of the Macedonians; but

[h] Calcutta Quarterly Magazine and Review, June 1827, p. 218.

[i] Rozet al Sefa.

the inquiries of Mr. Elphinstone[k], when on his embassy to Cabul, induced him to disbelieve the tradition. Lieut. Burnes also denies this descent of the Kafirs[l], although he thinks the pretensions of the chiefs of Badakhshan and the valley of the Oxus, which were first noticed by Marco Polo, better founded. Of the black-vested Kafirs he remarks, that they appear to be a most barbarous people, eaters of bears and monkeys, fighting with arrows, and scalping their enemies, circumstances quite in harmony with the character given by Ctesias of the Kalystrii. They are fairer than most Asiatics; and a Kafir boy of ten years of age, whom Lieut. Burnes met with, differed in complexion, hair, and features, from other Asiatics, and had eyes of a bluish colour, affording some authority for the white-complexioned children mentioned by Ctesias, those of a people who Pliny asserts were called by him *Pandoræ*, a genuine Sanscrit word, *Pandura* meaning *pale* or *fair*. Lieut. Burnes supposes the Siah-posh to have been the aborigines of the plains, who fled to the mountains from the advance of the Mohammedans. From information obtained by Messrs. Moorcroft and Trebeck, when in Little Tibet, it appears that the Siah-posh Kafirs are nothing more than a tribe of the people called by the Hindu geographers, both in past times and in the present day, Dáradas or Durds, दारद and who have borne that appellation from time immemorial, being the Daradræ of Ptolemy, situated at the sources of the Indus; and the Dardai of Megasthenes, as quoted by Strabo[m], who inha-

[k] Embassy to Cabul. Account of Kaferistan, 617.

[l] Travels to Bokhara, ii. 210. [m] B. xv.

bited the country of the gold-making ants. Now the sense of Dárada is *tearer*, *render*, from Dri, *to tear to pieces;* and this name, which is no doubt as old as Ctesias, may have contributed to form the canine teeth and talons of the people so called: whilst their other appellation, Kálavastri, indicating the usage which they still observe, and whence they are called by their neighbours Siah-posh, *black-vested*, that of *wearing black goat-skins*, furnished the denomination, Kalystrii, although the purport of it was inaccurately explained.

Of the other extraordinary tribes of Indians, whose existence rests either upon the authority of Ctesias or of subsequent writers, the origin may be with every appearance referred to India, being in one or two instances perhaps misrepresentations of facts, but in the greater number the assignment of a local habitation to the creations of Hindu fable. Thus, for the people with large ears, we find a class of demigods called Hastikarnas, *elephant-eared;* and large and long ears are features frequently ascribed to preternatural agents in Sanscrit fiction. For the Acephali we have the Kabandha, a headless but living trunk. One such personage is described in the Rámáyana[n] as seizing upon Rama, and his brother and wife, at the commencement of their exile: and another occurs in Ráhu, the personified descending node[o]: his head was struck off by Vishnu; but it was after he had quaffed the Amrita, or beverage of immortality; and head and body thence enjoyed a durable though divided existence. Horned satyrs appear in the Bhagavat, and Mono-

[n] Rámáyana Aranya Kánda.

[o] Vishnu Purána.

culi in the Kálíka Purana. As for a superfluity of limbs, and for monstrosity of form, there is an infinitude of such beings in the Hindu Pantheon, from the chiefs downwards to the meanest hobgoblin. Brahmá has four heads; Siva three eyes; Vishnu, in his Avatars, has the tail of a fish, the body of a tortoise, the head of a boar, the head and talons of a lion; Ganesa has the head of an elephant. Amongst the Dánavas, or children of Danu, the Titanic foes of the gods, we have one with the head of a tiger, one with the head of a goat, another has two heads, and a fourth has ears like sharp spikes[p]. Another of the wives of the patriarch Kasyapa, Khasá, is the mother of two sons, Yaksha and Rakshas; the former has two heads, four arms, four feet, enormous ears, and a proboscis like an elephant's; and the latter is a dwarf, with three heads, three feet, large ears, and disproportionate members: and these two were the progenitors of races equally monstrous. The demigods attendant upon Indra and Kuvera, the deities of heaven and of wealth, may well be termed Kinnaras and Kimpurushas, or literally *What-men, How strange a sort of beings!* for their synonymes are Aswamukha, Hayánana, and similar compounds, intimating that they have the heads of horses, from Aswa, or Haya, *a horse;* and Mukha, or ánana, *a face.* In the Bhagavat, the beings whom Indra sends to frighten Dhruva, and interrupt his austerities, have the heads of tigers, bears, and elephants, and the bodies of buffaloes, cats, and owls. And in the Kálíka Purana the train of Káma, the Hindu Cupid,

[p] Váyu Purána.

instead of the loves and graces, consists of the fiercer passions personified as beings with the heads of jackals, cats, and monkeys. Some of them have one eye, some have three, some have immense ears, some have one arm, some have many arms, some are giants, and some pigmies. The beings, too, that are supposed to live upon earth, haunting charnel houses and cemeteries, or the places where the dead are burnt, Pisâchas and Bhútas, besides being anthropophagi, are described as of gigantic stature and monstrous form; and these, and the races previously alluded to, may, either through oral description or sculptured representation, have borne the character of existing realities to superstitious and ill-informed traders and travellers.

With regard also to realities, we may perhaps trace the Monosceli to Hindu asceticism. One of the favourite exercises of a person performing tapas, or penance, is standing on one foot. This, in the legendary accounts of the austerities of various persons, who seek to compel the gods to grant them a boon, is done for a thousand years, and, in imitation of their devotion, for such period as is practicable by mere mortal sages. Representations of ascetics in this posture were probably frequent. Figures of Krishna and of Siva dancing on one leg also occur; and one of the names of the latter is Ekapád, Monoscelus. Again, notwithstanding the authentic portraits given us by learned men[q], of the umbrella footed gentry, it seems very probable, that, as Buffon has imagined, they originated in the diseased enlargement of one of the legs, the Cochin leg, as it is popu-

[q] They are engraved in Munster's Cosmographia, and Lycosthenes de Prodigiis, as pointed out to me by Professor Rigaud.

larly termed [r], but common in other parts of India besides Malabar; and which, though sometimes connected with elephantiasis, is not necessarily so. It is not unfrequently "a chronic complaint, inter-"fering in no degree with the functions of life [s]." It is not very clear what may be meant by the men with reverted fingers (οπισθυδακτυλοι), but they may perhaps be intended for the Urddhabáhus, ascetics, who hold up one arm until they cannot bring it down again, and keep their palms closed until the finger nails make their way between the metacarpal bones and appear at the back of the hand. However this may be, we can scarcely doubt that the Macrosceli, the long-legged race, were derived from a real source, as the word is little more than a translation of the Sanscrit *Tála jangha*, (तालजंघा:) people having legs like palm trees; the metaphorical denomination of a Hindu tribe which makes a conspicuous figure in the ancient history of India.

There is nothing else in Ctesias relative to the human species which is of any importance. "The In-"dians," he says, "make very good wine and cheese, "and he had tasted them." We need scarcely call his veracity in question here, whatever we may think of his taste. Cheese and wine are not manufactured in India Proper, but they are to the northward. The people of Bokhara use much cheese, according to Lieut. Burnes [t], and he also mentions the wines of Bokhara, which, he says, are unpalatable to European taste. That they were not so to Asiatic taste we have high authority; for the emperor

[r] Hist. Natur. de l'Homme, v. 64.

[s] Trans. Medical and Physical Society of Calcutta, i. 14.

[t] Travels to Bokhara, ii. 183.

Baber, who was in the early part of his life a boon companion, thus speaks of it: "In all Maweral-"nahar, there is no wine superior in spirit and "strength to that of Bokhara. When I drank "wine at Samarkand, in the days when I had my "drinking bouts, I used the wine of Bokhara[u]." Ctesias is therefore fully borne out in this particular, at least, by unexceptionable testimony.

NATURAL HISTORY OF INDIA.

We next come to our author's natural history, and first, of his accounts of the animals of India.

VII. Ælian IV. 21. Animals.

In this division of our subject, the foremost place is due to the formidable creature he describes under the denomination of Martichora, "an animal said to "have the face of a man and the bulk of a lion; to "be of a red colour, having three rows of teeth in "each jaw, with human ears but larger, and with "grey eyes; equipped with a tail above a cubit long, "pointed with a sting like that of a scorpion, and "armed with upright and transverse spines, a wound "from any one of which is fatal. When assailed by "a distant foe, the Martichora turns its tail in that "direction, and darts its spines from it like arrows "from a bow. It can cast these spines to the dis-"tance of a plethrum, and they kill any animal ex-"cept an elephant. The spines are a foot long, and "of the thickness of a slender cord. The meaning of "the martichora is *man-eater* (ανθρωποφαγος), as it "devours many of those whom it has slain; it also "preys upon animals. It fights with its talons as "well as its spines; and when any of the latter have "been shot away, others grow in their place. India

[u] Memoirs of Baber, 53.

"abounds with these animals, and they are often killed "with darts by men who hunt them on elephants."

Amidst the carnivora of the Indian forests, it would be somewhat difficult to discover the Martichora, and yet it would appear to be not altogether the product of our author's imagination. Indeed Ælian makes him assert that he had actually seen the animal, one having been sent from India as a present to the king of Persia. It may be, however, that he asserted he had seen only the representation of such an animal, which would accord with Heeren's theory of its origin[v], who describing the two sculptured figures on the east portal of the ruined buildings at Persepolis, delineated by Niebuhr, Morier, and Porter, and which have human faces, with the bodies of lions, observes, that the former characteristic convinces him that they were meant for the Martichoras of Ctesias, who in his narratives has here preserved legends current in Persia, derived from a mythological system of Oriental, Persian, or rather of Bactro-Indian origin. The elements of this mythological creation were, he adds[x], all real animals, the lion, the bull, the horse, the onager or wild ass, the rhinoceros, the ostrich, the eagle, and the scorpion, blended together in a variety of monstrous combinations, to which the fancy of the poet or the artist superadded a number of capricious ornaments. Although this may be true, yet the Persepolitan figures, being furnished with wings, and devoid of tails, can scarcely be considered as the prototypes of the Martichora, and we may still look to India for the original. Pausanias[y] thinks it is nothing more than the tiger; but although the tiger

[v] Vol. i. 154. [x] i. 152. [y] In Bœoticis.

may have contributed to its formation, yet some of the appurtenances cannot be traced to that source. The tail and its spikes seem rather to have been suggested by some imperfect reports of lizards or alligators, or still more, of the porcupine, which is well known in India, whence, it has been supposed, it was brought into Europe. It is found both in the plains and in the mountains. A belief in its power of shooting its quills, and of their deadly property, is as prevalent in India as it has been in Europe, and one of its names is Swá-vit, *dog*, or *wild beast piercer*. Others of its names are Saláká and Salya, meaning *a javelin* or *dart*. The body of the Martichora may be borrowed from a real animal, or from the Sinha, the mythological lion, on which the goddess Durgá rides, and the human face may have been a Persian embellishment, if it did not originate in some grotesque specimen of Indian sculpture. It can scarcely be doubted that Martichora, which seems to be the preferable reading, although it occurs Mantichora in Aristotle and Pliny[z], is a Persian term. Etymologists are here agreed. Reland[a] observes, "Hodie quæ mirabilis est linguæ Per-"sicæ constantia ανθρωποφαγος مرد خورا Mardi chora "appellatur a مرد *homo* et خوردن *edere*," and Tychsen[b] says Martichora is neither more nor less than the Persian Mard-khora, مردخورا, from مرد, *a man*, and خوردن *to eat*. Mardam-chora, مردم خورا also, as he observes, is a compound found in Persian writers to denote a fierce warrior. Thevenot, giving an account of some tribes in the south of India, who were accused of cannibalism, asserts that they were called Mardi khora by their neighbours. The latter

[z] Aristot. Hist. Animal. ii. c. 1 ; Pliny, viii. 21.

[a] Dissertations, vol. i. 223. [b] Heeren, ii. 377.

member of the term is in frequent use in India, in the sense of *eater*, as in the word halal-khor حلال خور, the name of a low caste, so called because they eat every thing, every thing is lawful food to them. If we admit that the Persian of the time of Ctesias was the Zend, we still preserve the affinity; for according to Du Perron's Zend vocabulary[c], the words would be meretê-khore. The same may be traced to a Sanscrit source, मर्त्य or marttya, *a mortal, a man*, and khâda खाद् *who eats*, marttya khâda; and there is no lack of anthropophagi amongst the creations of Hindu fable. The Rákshasas, Pisáchas, and Bhutas, the giants, ogres, and goblins of the Hindus, are all cannibals, as in the Bhatti, Khara and Dúshana, two Rákshasas, observe, "Day and "night we devour men, nor are we therein to "blame." The Bhágavata, describing such a being, says, "He drank the blood from the entrails, and "crunched the bones like lotus stalks;" and Mádhava, in the drama of Malati and Madhava[d], seeking to propitiate the spirits of ill, brings them raw flesh as an offering:

"Demons of ill, and disembodied spirits
"Who haunt this spot, I bring you flesh for sale—
"The flesh of man."

Men also may be condemned for a period to similar propensities; and Kalmáshapáda[e], one of the early kings of India, became a cannibal at the command of his spiritual preceptor, whom he had displeased, for a period of twelve years, during which, among others, he devoured his teacher's sons. Some such stories may have contributed the human heads to the body and talons of the real lion or tiger; and

[c] Zend avesta, vol. ii.
[d] Hindu Theatre, ii. 56.
[e] Mahábhárata, vol. i. p. 243.

the rest of the martichora have been compounded of the tail of the scorpion and the spines of the porcupine.

There was a chapter, of which the title only remains, concerning elephants who break down walls, τειχοκαταλυτων ελεφαντων. Ælian[f] adds, that they are trained to do so at the command of their princes, by applying their breasts against them. Elephants have been constantly employed in Indian warfare to force open the gates of fortified buildings, and it appears to have been a practice to exercise them against artificial ramparts or mounds. Thus in the Megha Duta, a large cloud sailing along the sky is compared to an elephant butting at a mound: III.

> ..... He beheld a cloud,
> In form some elephant, whose sportive rage
> Ramparts unequal to his might engage—

and *Vaprakrira*, literally, playing at or against a mound, is used to signify, the butting of an elephant. Some other particulars are cited from Ctesias by Ælian and Aristotle. The former states, that Ctesias relates having seen an elephant, at the command of his driver, overturn a palm-tree by a violent shock: a not improbable occurrence. The latter[g] denies the accuracy of the accounts which Ctesias has given of the procreation of these animals, and of the seminal excretion of the male becoming hardened like amber. As no other particulars are given, we cannot vindicate our author's correctness; but in the latter case it is possible that some misapprehension has occurred, and that the excretion alluded to was that which issues at certain seasons from the elephant's temples, and hardens like gum upon his cheeks; a physiological peculiarity frequently noticed by the Indian poets, as the excre-

[f] xvii. 28. [g] B. ii. c. 2.

tion is supposed, by its fragrance and sweetness, to have a strong attraction for bees, who thence infest the animal's head, as thus described in the Ritu Sanhara:

> Roars the wild elephant, inflamed with love,
> And the deep sound reverberates from above;
> His ample front like some full lotus blows,
> Where sport the bees, and fragrant moisture flows[i].

The circumstance is noticed by Strabo[k], but escaped all subsequent writers until the days of Cuvier[l]: according to him, the exudation is any thing but fragrant.

Ctesias, as Schlegel observes[m], in his history of the elephant, is the first writer who has described the employment of elephants in war; for their employment in this capacity by the Greeks was one of the consequences of Alexander's invasion. As quoted by Ælian, however, our author has exaggerated the numbers attached to the service of the king on such occasions: he makes them 100,000, a much greater establishment than Indian princes were ever known to possess. The number brought into action in India by Porus amounted to 200; but the Macedonians were terrified by the report that the king of the Gangaridæ could bring 6000 into the field. The highest of their numbers, however, leaves Ctesias chargeable with extravagance; and all that can be said in excuse is, that the exaggeration was probably Indian. According to Hindu writers, an *Akshauhini*, or full army, is formed of 109,300 foot, 65,610 horse, 21,870 chariots, and as many elephants; and in the Mahábhárata, which records the struggle for the paramount sovereignty of India between the kindred families of Kuru and Pandu, in which all the rajas of India

[i] Megha Duta, or Cloud Messenger, p. 28. n. [k] xv. 32.
[l] Ménagerie, t. i. p. 121. [m] Indische Bibliothek. vol. i. p. 2.

took part, the contending armies comprised many Akshauhinis, affording an original authority for 100,000, or even a greater number, of war-elephants being in array.

Another section treats of small monkeys having tails four cubits long. There is no want of monkeys of various species in India, but the long-tailed monkey, or Hanuman (Entellus), is not one of the smallest. III.

A chapter was devoted to Indian dogs, of whom the only particular that has been preserved is, that they were so large that they could fight with lions. That the Indian dog was highly prized by the Persians before the time of Ctesias, we know from Herodotus, as the animal was an article of import, and large packs were kept by the Persian king and nobles[n]. As these were dogs for the chase, they could not have been of the species of the wild dog of India; for this is an animal which it has been found impossible to tame. The Indian dog of the Persians must have been rather the dog of Tartary, of whom various breeds were kept for the purpose of hunting, as late as the thirteenth century; the grand Khan, according to Marco Polo, taking the field with a pack of 5000[o]. According to the same traveller, there are dogs in the province of Centigui[p], of such strength and prowess, that two of them are more than a match for a lion. The Tibetan dog is an animal of great strength and fierceness, though capable of domestication. Of the wild dog of India we have only lately had any authentic description; an account of the *buansu*, or wild dog of Nepal, having been published by Mr. Hodgson[q], and another of the *kolsun*, or same animal in Malabar, by Col. Sykes[r]. That V.

[n] Herod. i. 192. vii. 187. [o] Ramusios' edition, p. 28.
[p] Ibid. p. 40. [q] Asiatic Res. xviii. p. 2. [r] T. R. As. Soc. vol. iii.

these dogs hunt other animals in packs of eight or ten, and overpower not only buffaloes and wild cattle, but even leopards and tigers, was first stated by the author of the Wild Sports of the East; it was confirmed by bishop Heber; and is placed beyond doubt by the observation and inquiries of the last named authorities.

XIII. "Indian sheep and goats, it is said, are larger "than asses, and bring forth four or six lambs at "most. They have tails so large, that it is neces- "sary to cut them off from the female, to admit the "access of the male." On the other hand it is stated, that "amongst the pigmies the cattle are of the like "diminutive stature, the sheep are no bigger than "lambs in other countries[r], and the oxen, asses, "horses, and mules, and other beasts of burden, "are not larger than ordinary rams. There are no "swine, either wild or domestic."

Now it is perfectly true that the cattle of various parts of India differ materially in size. Several of the sheep and goats of the mountains are large and portly animals, and the domestic breeds are used, the sheep especially, for carrying loads; whilst the wild species, as the *bharal* or argali, and the *jamlah* goat, are, according to all accounts, animals of great size and strength. The *dumba*, or broad-tailed sheep, is common in central Asia. In Bokhara[s] all the sheep are of this kind; some of the tails yield as much as fifteen pounds of tallow. The animal looks deformed from its size, and straddles along with evident uneasiness. Some of the horned cattle of the northern provinces of India are tall and handsome animals, whilst the forests produce the two large species of the Gaur and the Gayal, and the buffalo

[r] Ælian iv. 26. [s] Burnes, ii. 174.

itself appears to have been known to the ancients as the Indian ox. The Turkman horse is celebrated for size and strength. On the other hand, the animals of the more southern parts of India are of a diminutive breed. The horses of Bengal rarely exceed thirteen hands, and the goats and sheep are of the smallest size. The zebu, or hunch-backed Indian cow, is not taller than an English calf; and there are still smaller breeds, some of which are not so large as a moderate-sized mastiff dog. With regard to the absence of the hog, we must here agree with Aristotle, that Ctesias is not worthy of belief, for both the wild and domestic kinds are known to the Sanscrit language, and the medicinal properties of the flesh of both kinds are described by Hindu writers. It is to be observed, however, that Ælian[t], who repeats the remark, adds, that the Indians abhor the flesh, and would as soon feed on that of man; a very superfluous disgust, if the animal was not known to them. It is quite true that no Hindus, except the outcastes, will eat the flesh of the *Gráma súkara*, *Gaon ka súr*, the village or tame swine; but the wild hog is permitted food, at least to persons of the military caste; and I recollect partaking of one which had been sent as a present from the raja of Bharatpur to the English officer commanding at Mathura. The wild hog was indeed an animal high in esteem amongst the Hindus in former times. The flesh of the wild boar offered to deceased progenitors, satisfies them for ten months[u], and to the goddess Káli, satisfies her for twelve years[x]. One of the principal avatars of Vishnu is denominated the Varáha, or boar, in which the deity, assuming

[t] Lib. xvi. c. 36.

[u] Menu, iii. 270.

[x] Asiatic Researches, vol. v.

the head of the animal, upraised upon his tusks the earth which had been submerged beneath the ocean; as in the concluding passage of the drama, Mudra Rakshasa, it is said of the earth,

> That erst, by power divine upborne, she rode
> Safe on the tusks of that celestial boar,
> Who snatch'd her from the o'er incumbent floods,
> And rear'd her green hills once again to heaven[y].

XI. Æl. IV. 26. Of hares and foxes it is asserted, "that they are "hunted, not with dogs, but with crows, hawks, "kites, and eagles;" and the statement is so far true, that in India, properly so called, dogs have never been associated with man in the chase. Hawking has long been common, both with Mohammedans and Hindus; and in native portraits of Nawabs and Rajas, it is very common to see the hawk sitting on the wrist of the individual who is delineated. It is doubtful, however, if the practice was not introduced by the Mohammedans; for there is no trace of this amusement in any of the Sanscrit poems or plays.

XXV. Æl. IV. 25. "India has wild asses as large as horses, with a "purple head, blue eyes, and a white body; they "have a horn on the forehead a cubit long, the "lower part of which, or that nearest to the skull, "is very white, whilst the middle is black, and the "tip red: raspings of this horn infused in any fluid "are a preservative against poison, and either wa- "ter or wine drank out of cups made of it, either "before or after swallowing poison, will prove an "antidote: drinking from such cups is also a pro- "tection against spasms and epilepsy.

"All other asses, whether wild or tame, and all "animals with solid hoofs, are without astragali and "without gall, but these animals have both." The

[y] Hindu Theatre, 2. 152.

bones which Ctesias says he had seen, he describes "as very handsome, they resembled the astragali of "the ox in form and size, but were as heavy as "lead, and of the colour of minium, externally and "internally."

"The Indian wild ass is a very strong and swift "animal; no other can overtake it. At first it runs "gently, but it increases its velocity as it proceeds. "It is captured only by this device:—when droves "of them take out their young to pasture, they are "surrounded by horsemen, and being unwilling to "abandon their young, they do not gallop off, but "remain and fight with horns, heels, and teeth, "and kill many of their assailants: at last, how-"ever, they are overpowered and slain with arrows "and darts; they are never taken alive. They are "hunted for their horns and astragali, for the flesh "is too bitter to be eaten."

In this account there is an evident confusion of right and wrong, and the circumstances obviously relate to two different animals, the rhinoceros, and the wild ass or horse; the former of which is really an Indian animal, whilst both the latter are numerous in the countries immediately north of the Himalaya.

The peculiarity of the horn, and the belief in its virtues as an antidote, belong to the rhinoceros. The same powers are generally ascribed by the orientals to cups made of it, as Chardin, speaking of the popular notion that prevailed in his day, observes; "On prétend qu'aux Indes les rois et les princes se "servent de cornes de rhinocéros à boire, à cause de "l'antipathie qu'elle a avec le poison lequel se re-"connoit en ce que le corne sue au moindre poison "qu'il y a dedans." A similar statement is given

in Wilkins's edition of Richardson's Dictionary. In neither the Heft Kulzum nor the Burhan Katia is this property mentioned, although they both state that raspings of the horn taken internally expel wind. The Makhzan al Adwíah, a medical work of great merit, notices that drinking cups are made of the horn of the rhinoceros; and Baber[z] relates that he had a goblet made from one: a belief in the alexipharmic virtues of the material was no doubt the reason for the fabrication of such vessels, and the notion seems to be very widely diffused throughout the East. Thunberg, at the Cape of Good Hope, observes, with regard to the horn of the African rhinoceros, it was esteemed for making drinking cups, as any poisoned liquor in them would ferment: he even submitted this to the test of experiment; but found, as might have been expected, the bowl was very unconscious of its drugged contents. In Persia we have seen that the idea prevailed in the time of Chardin, and one cannot doubt its currency in India. Buffon mentions various authorities to this effect. Mr. Forbes, speaking of the notion at the Cape, says it is as common there as in India; and in a little treatise on natural history, printed at Serampore, in Bengali, partly translated and partly original, it is said the Hindu physicians consider the horn, teeth, nails, skin, and other parts of the rhinoceros, as eminently medicinal in a variety of complaints, and that Indian princes have drinking cups made of the horn, on account of their being antidotes to poison. The same belief extends to the eastern Archipelago and to China, and it has been said, that to the latter, a thousand rhinoceros' horns

[z] Memoirs of Baber, 316.

are annually exported from Siam [a]. The horns are employed by the Chinese for supposed medicinal purposes. So far, therefore, little doubt can be entertained that the one-horned animal of Ctesias is the rhinoceros.

The Indian, or rather the Persian name of an animal, probably the same as the unicorn of our text, which also occurs in Ælian [b], identifies it with the rhinoceros. It is there termed *kartazon*, or *kartazonos*, καρταζωνος, and this has been corrected with very good reason, by Bochart [c], to *karkazon;* for the Persian name of the rhinoceros is *kargadan*, كرگدن; or as it is also read, according to the Burhan Katia, كركذن *kargazan;* both of them connected apparently with the Sanscrit appellation *kharga*. This in Bengali is confined to the horn, and the animal is in that language and in Hindi, called *Genda;* in this case we might have the compound, *s. khargaván*, *p. khargadán*, the original of the *kargadan* of the latter. Tychsen, adhering to the common reading, would explain it by كرك *a rhinoceros*, and تازان *running*, as if it meant the fleet rhinoceros: the compound is not known to the Persians; and whatever may be said of the speed of the rhinoceros, no person familiar with the appearance of the animal can associate with it the idea of swiftness. All that is meant probably by the accounts of its velocity, is, that it runs faster than might be expected from its figure: it is easily overtaken by a horseman.

Of the anatomical peculiarities noticed, it is true that many of the solid-footed animals, as the horse,

[a] Crawford's Embassy to Siam. [b] xvi. 20.
[c] Hieroz. P. 1. b. iii. c. 26.

ass, deer, have no gall bladders, and that the rhinoceros has: but the divisions of his toes exclude him from the class of solid-hoofed animals; and here, therefore, the description applies rather to the horse or ass, than to the rhinoceros. Animals with divided as well as undivided hoofs, however, have the tarsal bone, called the *astragalus*, unless Ctesias meant something else by the appellation. What use this bone was applied to, so that the animal should be hunted for it, is not described; but it might have been employed as a sort of dice in some game of chance, or worn as a talisman. According to the Makhzan al Adwíah, rings for the fingers and thumb are made from the horn, and they were possibly made from the heel bone also, to be worn as preservatives against venom. From its red colour, Tychsen supposes it must have been painted; but in that case the colour would have been only superficial; and it is worthy of notice, that Ælian says the colour throughout is 'black.' There is more plausibility in Tychsen's conjecture, that the various colours of the horn applied to it after its formation into a cup, when they were given to it by art; a supposition confirmed by the passage which he cites from Manuel Philo, in which the author asks an Indian prince [e] what the cup out of which he drank was made of, and which was ornamented with three rings, white, black, and red. The reply was, that it was made of the horn of the onager. At the same time it is to be observed that the horn of the rhinoceros appears to undergo a change of colour, and is sometimes grey, approaching to white; and the white is most highly valued.

[e] Heeren, ii. 384.

Of the flavour of the flesh it is to be remarked, that Persian physicians declare that the flesh of the horse and the ass is sweet to the taste, but bitter in digestion; whilst the Hindu medical writers affirm that the flesh of the rhinoceros is sweet: what is also more germain to the matter, Manu[f] declares it unlawful to eat the flesh of any animal with undivided hoofs, and enumerates the rhinoceros as amongst the animals that may be eaten. The Makhzan al Adwíah observes, also, that the flesh of the rhinoceros is halál, *permitted, good;* and the Bengali treatise, above referred to, states that the Hindus eat it. Here, therefore, Ctesias means the horse or ass.

Besides the singleness of the hoof and qualities of the flesh, the figure, size, and speed evidently refer to an animal of the family of the horse, and either to the wild ass, the Gor khar, or to the wild horse, the dzigtai or equus hemionus, or some other species, for both are common in the regions north of the Hindu Koh: the Gor khar, however, must have been well known in Persia, where it is still, as it ever has been, native, and a favourite object of the chase; and the wild horse is therefore more probably the animal intended. This, as found under the name of Kiang, in Ladakh, by Messrs. Moorcroft and Trebeck, was white about the nose, under the neck, and in the belly and legs; the back was a light bay, and the mane was dun: they herded in considerable droves, and the manners of the animal were such as Ctesias describes: at first he trots off gently, when a pursuer approaches, stops and turns, and looks at the object of his fear, and then flies off

[f] v. 11. and 18.

with unapproachable speed and irreclaimable wildness. They are occasionally, but with difficulty, shot, but never taken alive. It seems most likely, therefore, that this was the animal of whom Ctesias received accounts; but either he or his informants blended them with some imperfect description of the rhinoceros. The compound seems to have been in some respects a mythological one, as the sculptures at Persepolis contain several representations of the unicorn, with the body, according to Ker Porter[g], of a bull, but according to Niebuhr and Morier, of a horse.

III. Birds. There is a chapter on gallinaceous fowls of the largest size, of which the title only is preserved. Some of the particulars, however, seem to be given by Ælian[h], who describes the birds as having many-coloured crests, broad tails, feathers and plumage of partly a golden and partly an emerald colour. Ctesias might have alluded to the peacock, which was not known to the Greeks, apparently, before Alexander. Cuvier considers the bird described by Ælian to be the Impeyan pheasant (Lophophorus refulgens).

III. The parrot is well enough described[i] as "being of "the size of a crow, with a red beak, a black head, "and a blue or a red neck, with human voice and "speech, and talking either Indian or Greek, accord-"ingly as it was taught." The name of this bird, which, although it is read much more frequently Psittakus, Ctesias calls Bittakos, is derived by Re-

[g] Heeren, i. 154. [h] Æl. xvi. 2.

[i] Pliny, x. 42. Suidas in voce ψιττακος. Olympiodori Excerpta apud Phot. Diod. Sic. 2.

land from تدک, Tadak, one of the synonymes of a parrot in the Persian language. On this Tychsen remarks, "From this might come τεδακος, τιδακος, "σιττακος, and finally ψιττακος; and it is just pos- "sible that Ctesias might have written the name "Tedek, with a ب *b* instead of a ت, thus changing "it to Bittakos: but this," he adds, "is mere con- "jecture." And it is too much in the old style of etymological license to deserve much weight. The more usual sense of Tadak also is *heathcock*, and the current name of *parrot* is Tuti. The Sanscrit name Suka, or Sukas, furnishes some of the elements of Psittakus; and there is some approach to the latter in one of the generic names of a bird in Sanscrit, *Pitsat*, "habitually alighting." But no great stress need be laid on these coincidences. The conversational powers of the parrot have long been famous in India, though it should appear that they were novelties in Persia in our author's day. There is now, however, a popular collection of tales in the Persian language, supposed to be narrated by a parrot, the *Tuti nama;* the idea of which was perhaps suggested by a similar series in Sanscrit, the *Suka Saptati*, "the seventy stories of a parrot." The parrot and other birds, as the Maina or Grakle, and Koïl or cuckoo, have always been pets; as in the Mrichchakati: "The pampered parrot croaks like "a learned Brahman, stuffed with curds and rice, "chaunting a hymn from the Vedas; the maina "chatters as glibly as a lady's maid repeating her "mistress's pleasure to her fellow-servants; and the "koïl, crammed with juicy fruit, wheezes like a "water carrier[k]."

[k] Hindu Theatre, i. 86.

XVII. Æl. IV. 41. "There is also, it is said, a bird called Dikærus, "the meaning of which in Greek is δικαιος. It is not "larger than the egg of a partridge, and is remark- "able for concealing its dung, on purpose that it may "not be found, because the substance is of a poisonous "nature, and if as much as a sesamum seed of it be "swallowed in the morning by any person, he falls "into a sound sleep, and expires by sunset." Reland confesses he can make nothing of the name of this bird; and his conjectural derivation of it from the Persian دلمک, *Dilmek*, a venomous spider, is, as Tychsen observes, rather farfetched. The same, however, may be asserted of the etymology which he would substitute of دی, *Di*, "good," and کار, *Kár*, "maker," i. e. benefactor. If we might suppose an error in one of the letters of this word, and read it Ditæros instead of Dikæros, we might find a Sanscrit original for it in Tittiri, *a partridge;* or, if the initial were changed to a B or V, in Vikira, *a bird in general.* But these also are mere conjectures. Ornithologists have agreed to apply the name Dicæus to a class of small birds, of the family of creepers, which exists in India, the habits of which are not known, nor am I aware of the native name. According to Ælian, the colour is that of Sandarach, or red, which would apply to the little Amadavat finch. The effects of the dung, as described by that writer, identify it almost to a certainty with opium, small pills of which may have been mistaken for it, or have been metaphorically so termed. The death it induces is, according to him, a gentle dissolution, a sweet sleep. It was therefore regarded by the Persian monarch as the most acceptable present which the Indian sovereign

could send him, as an agreeable refuge, in case of necessity, from irremediable ills.

XVI. Reptiles.

Of reptiles, we have an account of "a snake nine "or ten inches long, of a purple colour, with a very "white head, and without teeth, which is met with "in the same mountains where the sardonyx is ob- "tained. It cannot bite, but any part upon which "its saliva falls mortifies. When suspended by the "tail it emits two kinds of venom; one whilst "alive, which is black, and like a sort of amber; "another after it is dead, which also is black. A "sesamum seed of the former kills immediately, "and the brain of the person comes away through "the nostrils. The latter brings on a gradual de- "cay, and proves fatal in about a year."

It may not be possible to identify the reptile here alluded to, but there are various small snakes in India to which deadly properties are ascribed. Several of the kinds of Typhlops, or blind snakes, are not larger than common earth-worms, being not above nine inches long, and not thicker than a crow-quill[l]. The bite of some of these is said to be fatal, whilst that of others produces extreme debility. Of one small species, Mr. Forbes[m] relates that its body is covered with a glossy slime, which it leaves like a snail wherever it crawls, and which is believed to be poisonous. Its teeth were visible, according to Mr. Forbes, only through a microscope; but Cuvier[n] says he had not been able to discover any teeth in those which he had examined.

[l] Russell's Indian Serpents, plates 36, 37, 42, 43.

[m] Oriental Memoirs, i. 229.

[n] Griffiths' Animal Kingdom, ix. 248.

The saliva, as well as other secretions of the snake, and of some other reptiles, is considered to be poisonous; and the poison of the snake is collected, and administered internally, for medicinal and deleterious purposes. In the poison described by our author, however, we might again suspect traces of opium, not only in its black colour and its effects, but in its concurrence with the sense of the Sanscrit name of opium, which is *Ahiphena*, meaning the foam, froth, or saliva of a snake. The history of this word, however, is uncertain, and instead of being the parent, it may be the offspring of οπιον (opium), through the Arabic *afiun*.

XXI. Æl. IV. 46. "There are in India insects of the size of a "beetle, of the colour of minium, having very long "feet, and as soft as worms. They are found on "the trees which bear amber, and feed upon and "spoil the fruit in the same manner as the phthires "do grapes. The Indians, by bruising these ani- "mals, obtain a dye, with which they dye robes and "tunics, and other articles of dress, of a scarlet "colour, very superior to the Persian dyes."

Although the description of the insect is not perhaps very exact, yet the remarkable peculiarity of its affording a scarlet dye identifies it either with the cochineal or the lac insect. Wilford[o] supposed it to be the latter; and its connexion with amber, which will presently be adverted to, or, in other words, with shel-lac, renders it probable that the lac insect is intended. Beckmann imagines it to be the cochineal, but Heeren[p] leans to the lac: he observes, "A third and no less certain class of pro-

[o] Asiatic Researches, ix. 65. [p] ii. 209.

" ductions which the Persians and Babylonians ob-
" tained from India, were dyes, and amongst them
" the cochineal, or rather Indian lacca." He infers also the domestic use of this dye in the colouring of stuffs, which were likewise imported, and which were nothing else than Cashmir shawls. Mr. Royle[q], in his Illustrations of the Botany of Northern India, conceives that the lac insect cannot exist both in the sultry plains of India and the cold and arid table-land of Tartary, to which Heeren refers it, and to which, or at least to Tibet, the locality of Ctesias applies. Admitting this to be the case, and that the insect in question was not the coccus lacciferus, a kind of cochineal is found on the roots of a plant in a marsh near Herat; and a similar insect, probably the kermes, is an article of considerable import at Herat from Bokhara and Yarkand, being brought originally either from Russia or China. Lieut. Burnes also describes a worm which attaches itself to the root of a plant growing luxuriantly on the banks of the Oxus, and other rivers in the same country, which produces a purple dye like that of cochineal. He says he compared it with American cochineal, and they appeared to be similar, only that the native preparation was softer. The people however do not well understand the management of the insect, although, in their imperfect process, it still produces a dye inferior only to cochineal[r]. It might therefore have been this insect, perhaps a kind of kermes, which is described by Ctesias as the produce of northern India, if it was not the lac

[q] Botany of the Himalaya Mountains, p. 85 and 225.
[r] Travels to Bokhara, ii. 169.

insect: but that this latter does not live in that direction is yet to be determined. It appears that this is not the only question that is doubtful regarding the lac insect; as in Griffiths' Animal Kingdom it is said that there is no very positive proof that the lac which is brought from India is owing to a cochineal. The description given of the insect by Dr. Roxburgh [s] conforms generally with those which have been published of the cochineal insect, though the plants upon which it is found embrace a greater variety, and the construction of its nest may differ. The name is Sanscrit, implying a multitude, from लक्ष, "a lac—a hundred thousand," in reference to the number of small insects found in a nest. And the denomination of *kermes* is also of Indian origin. Cochineal is called by the Persians *kirmiz*, from *kirm*, کرم, Sanscrit *krimi*, कृमि, a worm or insect.

I. XXVII. Æl. V. 3.

"The only animal which is found in the Indus is "said to be a kind of worm (σκωληξ), of the same "kind as that which is found in the fig-tree, vary- "ing in length, but commonly seven cubits long, "and so thick that a child of ten years of age can- "not grasp it. It has two teeth, one above, one "below, and with them devours whatever comes "within its reach. During the day, it burrows in "the mud, but at night it issues on the land, and "carries off oxen, or even camels. It is taken with "a large hook, to which a goat or sheep is fastened "with an iron chain. When captured, it is hung "up for a month, with vessels placed underneath, "into which runs as much oil as would fill ten "Attic cotylæ (or nearly five pints). The carcass is "thrown away, and the oil is sent to the king, no

[s] Asiatic Researches, ii. 360.

" other person being allowed to possess it. This " oil burns whatever it touches, consuming living " beings as well as timber and the like; and it is " only to be extinguished with soft clay."

In this reptile we have, no doubt, some imperfect accounts of the size, habits, and rapacity of the alligator; whilst, in some respects, the scolex may be no more than the hydrus, or water-snake. The flesh of the alligator is said by native physicians to be greasy, but I am not aware of any oil being extracted from it: at the same time, it may be practised in some parts of India. In an alligator, at the dissection of which I assisted, enormous masses of yellow fat were found under the skin, which might have been converted into oil. A coarse oil extracted from fish (matsya tailam) is in common use in India for different purposes: and the oily fat of the porpoise (Delphinus Gangeticus), which is probably an inhabitant of the Indus, is also considered as an external application of great efficacy for pains of various kinds. The flesh of the lion is also boiled down for its oil. For inflammable oils we have bhumi tailam (earth oil), or petroleum, and silajit, or bitumen, which is supposed to exude from rocks. Ælian adds, that the substance in question is used in sieges; and an earthen jar containing the oil being thrown against the gate of a town, the jar breaks, and its contents, taking fire, consume the place and its defenders. The Hindus appear to have had a knowledge of some kind of fire-arms in ancient times; and the Sataghni, or 'destroyer of a hundred,' is commonly described as a sort of rocket, a weapon which was generally used in Indian armies at a later date.

XIII. Plants. We have only the heading of a chapter on the Indian palm, with the remark that the fruit is thrice as large as the Babylonian.

XIX. "There are trees in the mountain regions growing "in the water, which at certain periods of the year "drop tears, like the almond or pine, or the like, and "this annually for thirty days; and these tears, fall- "ing into the water, become congealed. This tree is "called, in the Indian language, *siptakhora*, which "signifies in Greek, *sweet, agreeable* (γλυκυ, ηδυ), "and the Indians gather amber from it. The fruit "of some of these trees grows in clusters like grapes; "the kernels are as large as the nuts of Pontus."

There is nothing uncommon in India in the exudation of tears, or of a gum or resin, from a tree: and many valuable products of this nature, as olibanum, bdellium, mastich, kopal, katechu, and the like, are obtained from trees of Indian growth. The last-named resin is the produce of a tree, of which the name affords some resemblance to Sipta khora, the Sanscrit Sweta khadira, श्वेतखदिर, or, in the spoken dialects, Set-khair: but Sweta or Seta, श्वेत, means *white*, not *sweet*, which in Sanscrit is Swádu स्वादु. Reland and Tychsen agree in supposing khora to be derived, as in the case of Martikhora, from the Persian Khorden, *to eat;* and the former refers the first member of the compound to the word Sefa, صفا, *pure, pleasing*, which, as an Arabic, not even a Persian word, is quite inadmissible. Tychsen deduces it from Shifteh, شفتہ, asserting that Shifteh khor means *agreeable to eat.* Shefteh, Tychsen says, comes from Sheften, which means *to be in love;* and Shaftarang, Shaftalu are

applied to the peach and apricot (or rather the nectarine), as if, according to Wilkins, the fruit was of the colour of love, or was the apple of love. In the Burhani Katia, however, a well of Persian undefiled, one of the senses of Sheften is چکزیدن, *to ooze, to drop;* and this will agree well enough with the properties of the Sipta-chora tree. But it is said of this tree, that the Kalystrii, the Indians of the mountains, feed upon its fruit, and dry it like grapes, and make it an article of barter. Now this applies especially to the apricot, which appears to be in its native land in Tibet and the countries beyond the Hindu Koh, and is dried and exported in considerable quantities. At Kaubul, according to Mr. Royle, it is said to be preserved in fourteen different ways. At Balkh[t] it is so plentiful that 2000 are purchasable for a rupee, or two shillings. In the Himalayas the name of the fruit is Zard-alu Chulu, and Chinaru. It is imported into northern India under the Persian name Khubaní, or, *very good.* The manner of its growth does not accord with that described by Ctesias; but we must not expect to make every particular accord.

According to Mr. Royle[u], the peach, apricot, cherry, and plum, all exude gum in northern India; and in this we have the amber of the Sipta-chora. But here is probably some of that confusion which evidently pervades several of our author's descriptions, the blending into one article circumstances which are true of two or more. It is said of this tree, that the insects which furnish the red dye live upon it, and if that be the lac insect,

[t] Burnes, ii. 171.

[u] Illustrations of the Botany of the Himalaya.

the amber is probably nothing more than the substance of its nest, the resinous walls of the cells in which it breeds; in regard to which Dr. Roxburgh remarks, that it cannot be better described with respect to appearance than by saying it is "like "the transparent amber that beads are made of[x]." It may be some further illustration of Ctesias's account, that the inhabitants of the countries where his amber-dropping tree is said to grow, are still particularly fond of wearing beads of amber, or of some similar resin. They procure it through the Punjab and Caubul chiefly, but from what source is not known.

But we have still another tree, and this in the mountain which may have something to do with the Siptakhora, especially as the name Swadu-kola, or Swetacola, a sweet or light-coloured variety of the Badari or jujube might be applied to it. This is common in the jungles of northern India, according to Royle, where the fruit is dried and pounded. This kind also bears a kind of lac, which is used for dying leather, cotton, and silk[y]. And in the fruit and gum, as well as the name, therefore, a tolerably close approximation occurs. At the same time it seems most likely that the apricot furnished the principal features of the Siptachora, mixed up with others that belong to different trees. In fact the word Siptachoras, as he himself explains it, meaning merely sweet, or as Pliny[z] understands it, *prædulcis suavitas*, is applicable to any tree bearing sweet fruit.

[x] Asiatic Researches, vol. ii.

[y] Illustrations of the Botany of India, p. 170.

[z] Lib. xxxvii. 11.

" At the source of the Hyparchus river grows a XXI.
" purple flower which yields a purple dye no way
" inferior to that in use amongst the Greeks: it is
" rather brighter."

If we are to understand by purple (πορφυρα) a blue colour, the indigo plant readily presents itself. This grows as well in northern as in central India according to Mr. Royle, and lieutenant Burnes found a bastard species of it in the neighbourhood of Bokhara, although the true plant, he says, does not grow there. Its use, as a dye, was long known to the Hindus, as in the Pancha tantra, the collection of apologues, which is the original of Pilpay's fables[a], and which is known to be of a date anterior to the sixth century at latest, there is a fable of a jackal having tumbled into an indigo vat. The north-west of India, however, is rich in dyeing drugs, and the Rubia Manjith, or Madder, or the Kusumbha, *Carthamus tinctorius*, both growing abundantly beyond the Himalaya, might be the plant in question; the former yielding a deep red or crimson dye, and the flowers of the latter being employed for a rose-coloured, purple, and violet dye.

" The Indians have trees as tall as the cypress or XXVIII.
" cedar, whose leaves are broader than those of the
" palm, but like them in other respects, and without
" any axillæ. They bear a flower like that of the
" male laurel, but no fruit. The Indian name is
" Karpion, the Greek Myrrho-rhoda. They are not
" common. An oil exudes from them, which is
" caught by flocks of wool fastened to the tree, and
" thence transferred to alabaster vases. It is of a

[a] Transactions of the Royal Asiatic Society, vol. i. p. 164. Hitopadesa, b. iii.

" reddish colour and viscid consistence, but so fra-
" grant that its odour extends for five stadia. It is
" given only to the king and those about him. The
" king of India made a present of some to the king
" of Persia, and Ctesias says he saw it, and the
" smell was such as he could not describe, except
" by saying it was unlike any other."

The fact of a fragrant oil, or perhaps rather of a fragrant paste, having been sent from India to Persia, can scarcely be questioned. This could not have been *atr* of roses, not only from the description of the tree, but from the peculiarity of the odour. Had that been the fragrance of roses, Ctesias need not have been at a loss to describe it. The perfume to which the account of it best conforms is that of Sandal, which is very generally used in India, both as a paste and a viscid oil, and is obtained from the wood of a handsome tree, although it does not resemble a palm in its foliage. The name *Karpion*, however, does not belong to the sandal tree, nor to any other Indian plant, as far as I have been able to ascertain. The nearest approach to it is the Sanscrit Karpura, which, through the Arabic modification Kafur, has supplied the European term *camphor:* an oil of camphor is extracted from the tree, and well known in India, and the drug is obtained from a species of laurel, according to Kæmpfer[b], as well as from a variety of trees not so properly the growth of India as of the countries to the eastward, or Sumatra and Malacca. This might have found its way through India to Persia; but, unless mixed with some other substance, would not have been of a reddish tint. Nor is the etymological af-

[b] Asiatic Researches, vol. xii.

finity very satisfactory, although it is fully as much so as any other proposed. Reland derives Karpion from the Arabic name of cinnamon, قرفه, which, however, is a derivative from قرف, *decorticavit*, and means the peeled bark, not the tree. Tychsen agrees in supposing the latter to be meant, on the authority of Paulinus a Bartholomæo, who asserts that the Sanscrit name of cinnamon is Karuva, but no such Sanscrit word occurs in medical vocabularies, and it is more properly the Tamil term, Kárruwá. I am not aware, however, that an oil of cinnamon is known in India.

" There is a sort of wood (or rather a tree) called XVIII.
" Parēbon, or Parubon (παρηβον, παρυβον). It is of the
" size of the olive, and is found only in regal
" gardens. It bears neither flowers nor fruit, but has
" fifteen roots under ground, each of the thickness of
" a man's arm. A piece of this, of a span length,
" attracts every thing to which it is directed, gold,
" silver, brass, stone, and all substances except amber.
" A piece of a cubit in length will attract even sheep
" and birds, and it is employed especially to catch
" the latter. If you wish to congeal water or wine,
" put three oboli of the root into a gallon of fluid,
" and it will become like wax, so that it may be
" held in the hand. It liquefies again in the course
" of a day. It is of benefit in cholic."

The wonders related of this shrub, or wood, have originated perhaps in the properties of some plant with a viscid or glutinous juice, to which light substances may adhere, and which mixed with fluids forms a strong mucilage and demulcent. Many of the Malvaceæ and Tiliaceæ, affording mucilaginous juices, are found in India, and a strong mucilage

used as a demulcent is prepared from the seeds of the holy Basil. The employment of Lásá, لاسا or bird-lime, to catch birds, is well known in India, and it is obtained from various plants: amongst others, from the stem of the Indian and the religious Fig. Reland has not made any attempt to explain the origin of the name Pariban, which Tychsen resolves into the Persian compound Bár-awar بـــاراور, "load-bringing." The first part of the term may be referred to the Sanscrit *pari*, परि, "about," "back "again," and the latter to *vana*, "a grove:" *pari-vana*, "in or about a grove, or garden:" but there is no authority for such a compound, although *pâri* occurs as part of the appellation of different trees, as *pâri-jata*, "the coral-tree," *paribhadra*, "the silk-"cotton."

VI. "In the plains and mountains through which the "Indus runs there grows the Indian reed. This varies "in dimension, some being larger and some smaller, "but there are some so thick that two men with their "arms extended cannot encircle them, and some are "as lofty as the mast of a merchant vessel. These "reeds are male and female, and the female has a "sort of medulla which the male has not. The latter "is the larger."

We need not be at a loss in this account to recognise the Bambu, which grows abundantly in most parts of India, and often attains a considerable size. The height is not at all exaggerated. The circumference exceeds the truth, as the largest kind which is found in Ava and Pegu rarely exceeds twenty inches in girth. Ctesias, however, is less extravagant in this than even Herodotus [c], who asserts that a single

[c] iii. 98.

joint of the bambu is sufficient to form a canoe. The distinction of the plant as male and female, the latter being so considered from its more slender form and larger cavity, has been preserved in popular language to the present day. By the Enterione (εντεριωνη), the pith or medulla of the female bambu, Ctesias probably intended the peculiar substance found especially in the smaller kind of hill-bambu, long known to Oriental physicians as *tabasheer*, and highly prized as a febrifuge, demulcent, and restorative in Persia, Arabia, and Turkey. This, which is at first a watery fluid, gradually becomes viscid, and finally solid, of an *opal* or milk-blue colour, more or less semi-transparent; whence the latter part of its name *shir*, from *kshir*, "milk." It has been the subject of careful investigation, in the first instance, on account of its supposed medicinal virtues, and latterly for its curious optical properties, and very low refractive power. Dr. Russell has treated of the first in the Philosophical Transactions for 1790, and Sir David Brewster of the latter in the same collection for 1819, as well as in his Journal, November to April, 1828. The latter writer considers it to be nothing more than the sap of the bambu extravasated into the hollow in consequence of a disease in the spongy part of the internodal substance through which it should properly circulate. Humboldt is of opinion that Salmasius has rightly referred the saccharon of Pliny to the medulla of the bambu [d], describing it as a honey collected in canes, of the whiteness of gum, crumbling between the teeth (*dentibus fragile*), in lumps about the size of a filbert, and used only in medicine; con-

[d] xii. 17.

cluding from this and other notices found in ancient authors respecting sugar, that hard sugar was unknown to the ancients, and that when they speak of a solid sugar they mean tabasheer, or sharkara of bambu [e]. Unfortunately, however, for this conjecture, the little flavour that tabasheer possesses is rather salt than sweet, and in its dry state, in which alone it is exported, it is so hard that it would be much more likely to break the teeth than to be broken by them. The saccharon of Pliny is much more likely to be manna, which is an Indian as well as an Arabian product. The allusion to the interior secretion of the bambu by our author is valuable as a test of his accuracy, and of the probability of the substance being then, as it has ever since been, an article of imaginary, if not of real medicinal value; the notion being derived from the medical writers of the Hindus, which describe the Bans-lochana, also called Twak-kshiri, whence Tabashir, as nutritious, strengthening, aphrodisiac, sweet (medicinally), and cooling; a remedy for thirst, fever, consumption, asthma, bile, blood, jaundice, and leprosy. "Bháva "Prakás."

IV. Minerals.

There is little more than the heading of a chapter which treats of a fountain of liquid gold [f], "which is drawn off, it is said, in vessels of baked "clay to the extent of a hundred annually, each "holding one talent. The gold hardens as it is "drawn, and it is necessary to break the vessels to "get it out. It is a square fountain, sixteen cubits "in circumference and one in depth."

[e] Humboldt on the natural family of the Grasses. Quarterly Journal of Science, vol. v. 51. and vol. vii. 363.

[f] Philost. de v. Apollonii 3.

This looks like some imperfect account of a bed or furnace in which gold had been melted or refined, and had been drawn off for casting in earthen crucibles.

In another passage it is stated, that " gold is not " obtained in India from the sands of rivers by " washing, as it is from the Pactolus, but is found " in lofty mountains inhabited by griffins. These " are birds with four legs, of the size of a wolf, " with the legs and claws of a lion, having red " feathers on the breast, but black on the rest of " the body. It is difficult to procure the gold on " account of these birds." XII. Ælian. xxxvii. 4.

Although it is not true that gold is not found in the sands of rivers in India, as those of many of the hill streams of the Himalaya [g], and those of the Oxus are washed for the ore, yet it is found native in various parts to the north of the Himalayan chain, as in the country of the Kafirs and in Tibet [h], and is sometimes met with in considerable lumps. In the latter country a popular prejudice, and even the orders of the government, are adverse to its collection; for it is believed to be the property of certain spirits, the genii of the place, and the special ministers of the God of wealth, whose anger is excited by any attempts to despoil them, and, unless appeased by suitable homage, proves fatal to the sacrilegious individual who has taken away the metal. These superstitions may have formed the basis of the stories of griffins and of ants as large as dogs; the former of which is alluded to by our author, and the latter described more particularly by Herodotus, Ælian, and Strabo. The γρυψ, *grups*, or *griffin*, of the text, may very probably be con-

[g] Burnes, vol. ii. p. 165. [h] Ibid, vol. ii. p. 211.

nected, as Tychsen supposes, with the Persian verb, گرفتن, *to seize;* whence the German *greifen*, and our words *grip, gripe;* the whole family being related to the Sanscrit *graha, grihitum, to seize*, or *lay hold of.* The anomalies of his form may also be Indian, and borrowed from the Garura, the bird and vehicle of Vishnu, who is commonly represented with the head and wings of an eagle, and the body and limbs either of a man, or a bird of gigantic size. In the latter case he is sometimes represented as carrying an elephant in one claw, and a tortoise in another. A modification of Garuda also occurs in the south of India, in the Gandabharunda, a bird with four claws, each holding an elephant. There is also a bird called in Menu, Hema-kára, *gold-maker;* which, according to Wilford, is commonly described as of vast stature, living in the mountains to the north-west of India, whose dung mixing with the sand of the country converts it to gold. A bird that voids gold is mentioned also in the Panchatantra [i]. The belief in the existence of such an animal as Ctesias describes was probably established in Persia when he resided there; for, as Heeren observes, his description so exactly coincides with some of the Persepolitan sculptures, that it would almost appear as if he had seen the relievo, or the artist had copied his description [k]. With regard to the ants, although they are the creatures of other narrations, it may be observed, that some vestige of the notion may be discovered in Hindu fable and popular belief. All hidden or subterraneous treasure is conceived to be

[i] Transactions of the Royal Asiatic Society, vol. i. p. 179.

[k] Heeren, vol. i. p. 183.

under the especial protection of the Nágas, the snake gods inhabiting Pátála, and who commonly appear as serpents, though they may take what form they please. An interesting instance of this belief is given by Mr. Forbes[l], where, in searching a deserted building for treasure, his people found a large snake where they expected money. But the circumstance that connects this with the story of the Greek writers is, that these snakes, and their charge, are very usually found in *Ant-hills*, in the mounds thrown up by the Termites. Thus in the story of the snake and Brahman's son in the Panchatantra[m], the Brahman having learnt the fact in a dream, finds and worships a hooded-snake, whose abode is an ant-hill; and who, in consequence, gives him money and a rich jewel. There is, therefore, an ancient connexion in Hindu belief, between the Termites and buried treasure; and it is possibly from this source that the ants of western fiction have been derived and embellished. The size Wilford[n] supposes to have originated in a verbal error, confounding the Hindu name of an ant "chyunta," چیونٹا, with that of the hunting leopard chíta, چیتا. This is not impossible; but perhaps it proceeded from some perplexed account of the nest of the white ant. Small as the animal is, it throws up burrows of considerable dimensions. I have seen a field strewed with ant-hills as big as moderately sized haycocks, and they are met with larger. This may have been represented as the ant itself, as big as a fox or a Hyrcanian dog.

[l] Oriental Memoirs, vol. ii. p. 21.

[m] Transactions of the Royal Asiatic Society, vol. i. p. 176.

[n] Asiatic Researches, vol. xiv.

XI. "India, it is said, abounds with silver; and mines "are worked there, although they are not so deep "as those of Bactria." There are no silver mines worked in either country now, and it is not known if the metal exists.

IV. "At the bottom of the gold fountain, previously "noticed, Ctesias says, that iron is found, of which "two swords had been fabricated, and given him by "the king and queen-mother." It is to be inferred, that some more than ordinary value was attached to the stuff of which these swords were made; and it is interesting to find, that Indian steel, Foulad, or Wootz, is still highly prized in the Persian market for the same purpose. The greater part of that which is manufactured in the peninsula, in Hyderabad, or Golconda, is conveyed to Persia[o] by agents from that country, who monopolize the whole of the fabric. The steel is used in the formation of various articles of hardware, but especially in that of the celebrated Damascus or Persian sabre.

Ctesias tells us also that he witnessed the property possessed by rods of the same iron, of averting storms and dissipating heavy clouds, when set upright in the earth. It would seem as if the Persians had some notion of electrical conductors; but the marvel is probably of easy solution; and the clouds passed over, and the storm dispersed, without being materially affected by the iron rods.

V. A chapter contained an account of the great mountains, where the sardo, onyx, and other precious stones were found.

Heeren is of opinion that this refers to the moun-

[o] Journal of the Asiatic Society of Bengal, vol. i. p. 245; Buchanan's Travels in Mysore, vol. ii. 19; Heyne's Tracts on India, p. 358; Tavernier's Voyages.

tains of the Karakorum range, and the country of Badakhshan, where the lapis lazuli is still found in the greatest perfection. In the section, however, XVI. treating of the snake whose saliva is so venomous, it is said to be met with in the mountains which produce the sardonyx, and these are described as very hot. We must therefore go more to the southward for the minerals here mentioned, and these are found in the mountains of the west of India. Carnelians, agates, and mocha stones, are found on the Narbadda, and form a valuable part of the trade of Cambay [p], to which the onyxes and other stones from the sardonyx mountains of Ptolemy have been transferred from their former emporium, Barygaza, or Baroach.

" There is a lake of the circumference of 800 XI. " stadia, on which, when there is no wind, a cer- " tain oily substance floats, which they collect with " buckets. The Indians also use oil and sesamum " from seeds; but that which is taken from the lake " is considered the best."

A variety of oils is extracted by the Hindus from vegetable seeds for culinary purposes, for oiling their hair and persons, and for burning. The only oil that can be identified with that of a lake is the earth oil, or petroleum, which is obtained from wells in Ava [q], floating on the surface of the water. In Cachar [r] a very fine petroleum oil was found floating on water, issuing from the base of a cluster of hills. Something of this kind may occur in the

[p] Forbes's Oriental Memoirs, vol. i. pp. 322, 465; and Transactions of the Bombay Society, vol. i.

[q] Crawford's Embassy to Ava, p. 53.

[r] Gleanings of Science, vol. i. p. 283.

north-west of India, and have been the origin of the lake which Ctesias describes.

XIV. " A river flowing from a rock is said to flow with " honey." This is perhaps a misunderstanding of a figurative appellation. I do not know of any river called in Sanscrit Madhumati, *honey-having;* but it is a legitimate compound; and several streams have the analogous appellation of Ikshumati, or *sugar-flowing, sweet;* in allusion to the fancied sweetness or purity of the water.

XIX. " A river running through India, two stadia broad, " is called by the Indians, Hyparchus, which means, " *bearing all good things.* For thirty days in the " year its waters bring down amber."

This latter circumstance connects it with the Siptachora, or amber shedding tree; and Wilford would consider Hiparchos as nothing more than a corruption of *Sipa-chor*, which again he resolves into *Aspa-cora*, observing that the river was probably thus called because it came from the Sipa-chor, or Aspa-cora country. A town called Aspa-cora is placed obviously, he says, in the country of Tibet, by Ptolemy, and in the Peutingerian tables. The present situation of Aspacora, he observes, is unknown, but he quotes the authority of a native traveller for *gor* and *kar*, being frequently used in combination with other words as the names of places. The river he would identify with the present Tistah. All this however is very unsatisfactory, except the possibility of some connexion between the terms *Sipachora* and *Aswa*, or *Aspacora*.

Reland and Tychsen have not, I conceive, been more happy than Wilford in their etymology of this word. The former derives it from Av, or ap,

او, or اب *water*, and پرخ, perkh, *utility;* a combination as much Greek as Persian. The latter proposes Awar-khosh, اورخوش *the bringer of good.* The Persian form of such a compond would however be Khosh-awar. Pliny[s] reads the word Hypobaros, and if his reading be correct, it may be referred to upa-bári, *minor*, or *lesser water;* or su-bári, *good water.*

" There is a fountain of a square form five ells in xxx.
" circumference; the water is in a rock three cubits
" above and three ells below the surface. In it the
" most respectable persons, men, women, and chil-
" dren, wash; not only for cleanliness, but for health.
" Those who bathe in it plunge in, and the water
" bears them up. Nothing, indeed, can sink in it,
" except iron, copper, silver, and gold, which fall to
" the bottom. The water is very cold and sweet, and
" rises with a bubbling noise, as if it was boiling in a
" caldron. It is beneficial in vertigo and scabies. It
" is called Balladee by the Indians, which means in
" Greek οφελειμα, *useful.*"

There are many mineral springs in India which evolve gaseous matters, but they are in general hot springs. They are very frequent in the hills in Kashmir and Tibet, but their properties have not been investigated. The term Balladee, Reland would derive from Belad, بلاد, *laudatus*, because what is useful deserves praise. Tychsen traces it to ولا, or ولاد, *strong, eminent.* He quotes also the authority of father Paulinus, to shew that Ballam is the Sanscrit for *water*, and Nallada, for *good.* These are Tamil, not Sanscrit words. Heeren's translator suggests a much more likely affinity to Balladee in the Sanscrit Baladá, or Baladí, बलदी, *giver of strength:* and either that or Phaladá, Phaladí,

[s] Lib xxxvii. 2.

फलदी, *giver of fruit*, or *benefit, beneficial*, is probably the original of the word which Ctesias has preserved.

XVI. "Of another spring it is related, that the water as "soon as it is drawn curdles like cheese, and if as "much as three oboli of it be drunk, the person so "drinking becomes deranged, and relates every thing "he may have done. The king, therefore, employs it "to detect guilt. If the persons accused of any great "crime confess their deeds, (under the influence of "this potion,) they are put to death, if not, they are "set at liberty."

The curdling of the water may have been suggested by a deposit of earthy matter diffused through it whilst it was running, but precipitated when stagnant, like the tufa deposits of many springs in the Himalaya. The application of it, however, is nothing more than the Hindu ordeal, one of their five divine tests of guilt. According to the text of Yajnawalkya, the balance, water, fire, poison, and sacred libation, are divine tests for purgation. In the ordeal of water, the accused is thrown into a pond with his hands and feet bound; if he sinks he is innocent, if he floats, guilty. In the ordeal of poison some deleterious drug is administered to the accused with clarified butter. In taking it he recites this prayer: "Thou, oh Poison, art the son "of Brahmá, steadfast in truth, relieve me from "this accusation, and by means of thy virtue be-"come as nectar to me." If after swallowing the draught no change is observable, whilst the hands are clapped together for five hundred times, the accused is acquitted. The clarified butter, the menstruum of the poisonous draught, may be the origin of the curdled water.

The only article that remains to be noticed is the marvellous gem the Pántárba, of which all that is recorded is its having recovered from the river, into which they had been thrown by a certain Bactrian pedlar, seventy-seven jewels and precious stones sticking together. It does not appear whether they were thrown in purposely: offerings of precious stones to a sacred stream would have been genuinely Hindu, and there is an indication of an Indian original in the number of the jewels, for seven is the tale of various articles of peculiar sanctity in Hindu mythology, as in the Hanuman Nataka, when Ráma drives his arrow through seven trees, then the seven steeds of the sun, the seven spheres, the seven sages, the seven seas, the seven continents, and the seven mothers of the gods are alarmed. The gem that recovers these valuables has however no certain prototype in Sanscrit, unless it be intended for nothing more than it evidently is understood to be by Philostratus, (iii. 45,) a magnet. That was well known to the Hindus as the akarsha prastara, *the attracting stone*, or the ayas kánta, *the aimant, the beloved of iron*, as in the Málati and Mádhava, the lover says of his mistress; "She at the very first glance attracted my "heart as a rod of the magnet-gem draws the iron "metal towards it." It is not said that Pantarba is an Indian word, although it may not be Greek. Reland has not noticed it: and Tychsen's etymology بند در یای, *a binding*, or *attraction, underneath;* that is, below the water, is sufficiently improbable. The last part of the word offers some affinity to ruba, ربا, *stealing, robbing*, as in Dil-ruba دلربا, *heart-stealing*. For the first part we might suggest panj, or panjah, *five*, or *fifty*, connected with the

II.

Sanscrit pancha, and the Greek πέντε. The word may possibly, however, be nothing more than a perversion of ahan-ruba, the *iron-stealer*, the *magnet*.

I have thus completed the view which I purposed to take of the narratives that Ctesias has transmitted to us concerning India. The examination to which his statements have been submitted leaves, no doubt, much that is as inexplicable and as impossible as ever; but it will be perhaps admitted to be as satisfactory as any by which it has been preceded, and to be upon the whole favourable to the reputation of the Greek writer. Whatever may be thought of the individual instances in which an attempt at verification has been made, it will probably be conceded that the general character of the story indicates an Indian original, and that the account is not entirely the audacious invention of Grecian mendacity; that amidst much extravagance and incredibility there do appear glimpses of truth; that the description does seem to have been compiled from information, which, however loose and erroneous, was gleaned by actual travel and observation; and that it presents to us a picture of India, in which, however strange in themselves, or distorted by ignorance and credulity, there are authentic features of the country and its natural productions; and of its people, their usages, their arts, their superstition, and their language: and, consequently, that the authority of Ctesias is of value, as evidence of the existence of many of the characteristic peculiarities of India and the Hindus, such as we still find them, two thousand two hundred years ago.

AN ACCOUNT

OF THE

ROMAN ROAD

FROM

ALLCHESTER TO DORCHESTER,

AND OTHER

ROMAN REMAINS

IN THE NEIGHBOURHOOD:

BEING THE SUBSTANCE OF A PAPER READ TO THE ASHMOLEAN SOCIETY, NOV. 9, 1840.

BY

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STUDENT OF CHRIST CHURCH.

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AN

ACCOUNT OF THE ROMAN ROAD

FROM

ALLCHESTER TO DORCHESTER.

THE remains of antiquity, such as are now to be described, are so liable to destruction from the progress of agriculture, and other changes on the surface of the soil, that it may be useful to record the present state of them, even although they have been often noticed before. Let this be my excuse (if excuse be wanted) for including in the following account many observations which others have made in some parts of the same subject. But the same process which is daily in operation to destroy some antiquities discovers others: the plough has brought to light many an unknown Roman work. But a great part of these is likely soon to be lost and forgotten, unless put on record; it is important therefore that such notices should be collected, and that this should be done at the time when the discovery is made. Every accurate description of local antiquities, whether it be the actual condition of those which have been long known, or the discoveries of new remains, may, therefore, be of service to the general interests of history; and all who have opportunity for it, might be encouraged to examine and observe such matters of antiquity as fall in their way, by the thought, that while they amuse themselves by such pursuits, they may also

contribute something to increase our knowledge of the early state of our country. With this view I lay before the Society the following sketch of objects which are within the reach of all to examine.

But I wish first to acknowledge what I owe to the kindness of friends. Of the Rev. Walter Lucas Brown, rector of Wendlebury, and late Student of Christ Church, I am bound to say that he has not so much *assisted* me in the work as *shared* it *with* me, and the authorship really belongs in part to him. I consider that very much of the value of what is here produced is due to his excellent drawing of the ground of Allchester, and the information about it with which he supplied me. I am much indebted to the Rev. John Wilson, Fellow of Trinity College, for many interesting facts and observations, which I should not have had without him. His assistance has been of great service to my inquiries in many respects; and it has been given always most freely and kindly, which I acknowledge with pleasure. And I have also to thank the Camden Professor of Ancient History, Dr. Cardwell, Principal of Alban Hall, for some additional information, and references to authors with which I was not acquainted: and other friends also, whom I need not name here. Let me add an acknowledgment of the great help derived from the Ordnance Map. This excellent work has now given facilities to antiquarian researches of this kind such as they never had before; while it has, at the same time, collected together a great store of notices of the remains of antiquity, in a more accessible shape than formerly belonged to them, and preserved them in a record which will remain for purposes of

history, even although the increase of population and cultivation of the soil should obliterate every trace of the relics themselves from the surface of the country.

THE Roman Road running across Otmoor from north to south has long been known. In Camden's time the tradition of the country confounded it with the Akeman-street, and he described it by that name [a]. Since this it has been observed by many antiquaries, and it is still familiarly known in the neighbourhood as " the old Roman Road." It has generally been thought to end at Allchester, to the north, although Camden was told that it was carried on to Banbury. Whither it went in the opposite direction, to the south, was for some time a doubtful question with antiquaries: the account given to Camden by the people of the country was, that it reached from Banbury to Wallingford. Plot also supposed that it went to Wallingford, crossing the Thames at Bensington, where he thought that there was a portion of it visible to the west of the church, under the name of Medler's Bank [b]. Stukely con-

[a] Camden (Dobuni) Oxfordshire.

[b] Natur. Hist. of Oxfordshire, 27. p. 317, &c. I cannot find that the name of Medler's Bank is known at Bensington now. There is a *very faint* trace of something like a continued ridge running near the turnpike road all the way from Dorchester to Bensington in a straight line between the two churches, but it is too slight to found any speculation upon. If this however really was the line of a Roman road, it was a branch leading off from Dorchester, not in the straight direction of a continuation of the road from Allchester, but bending with a considerable angle from it.

jectured that it was carried to Sandford, and crossed the river there [c]. Warton describes it as connecting Allchester and Dorchester; although it does not appear from his account of it, how much he had traced himself, and how much he derived from the information of others; and his description of some part of it, where he goes a little into details, does not agree either with the present form or the place of it [d].

It seems evident that this road must be the same which is mentioned by Richard of Cirencester in the route from York to (near) Southampton. In the eighteenth iter Richard gives the distance from Ælia Castra (Allchester) to Dorocina (Dorchester) as fifteen miles; and the editor in his comment on the place observes, that the road "runs plainly almost all the way to Dorchester [e]." The true distance

[c] Itinerarium Curiosum, Iter II.

[d] Specimen of a History of Oxfordshire, p. 57.

[e] The following is from the London edition, 1809, of Richard of Cirencester, p. 164.

Iter XVIII. Ab Eboraco per medium insulæ Clausentum usque, sic:		Corrected numbers.	Sites of the Stations. From York through the middle of the island to Bittern.
Legiolio	m. p. XXI	XXI	Castleford.
Ad Fines	XVIII	XXIII	Temple Brough on the bank of the Don.
.....	XVI	XVI	Tapton Hill near Chesterfield.
.....	XVI	XII	Camp near Pankridge.
Derventione	XVI	XII	Little Chester.
Ad Trivonam	XII	XII	Berry Farm in Branston.
Etoceto	XII	XII	Wall.
Manduesuedo	XVI	XVI	Manceter.
Benonnis	XII	XII	High Cross.
Tripontio	XI	XI	Near Dove Bridge.
Isannavaria	XII	X	Burnt Walls.
Brinavis	XII	XII	Black Ground near Chipping Norton.
Ælia Castra	XVI	XVI	Alcester near Bicester.
Dorocina	XV	XVI	Dorchester.
Tamesi	VI	VI	On the Thames.
Vindomi	XV	XX	Silchester.
Calleva			
Clausento	XXXXVI	XXXXV	Bittern near Southampton.

from Allchester to Dorchester by this line is sixteen miles, one more than Richard reckons; but this variation is inconsiderable, being much less than what is found in many of the numerals of the old itineraries. About half of it has been traced by the antiquaries above-named. The course of the road can be seen on examination every where, except in a few portions, so small, that the direction is easily recovered; and these intervals lie towards the middle of the whole distance; so that at each end it is most plain.

To begin then from the north, the road passes through the middle of the area of Allchester in the form of a high ridge, which is continued through the meadows to the south, in a course a little westward of Merton. It is now about twenty yards in width, being measured over the curve of the surface, which was the regular width of the Via Prætoria in a camp[f], and about two feet and a half high:

Instead of Chipping Norton we should read Chipping Warden, which is half a mile from the Black grounds, the supposed site of Brinavis. See Mr. Beesley's History of Banbury, p. 27. But even this seems too far to the westward for the direct line. If it were certain where Isannavaria was, we could guess the site of Brinavis with more probability. Gale supposed that Isannavaria (or Isanta Varia, (Richard, Iter 1,) or Isannavatia, or Isannavenna, or Bennaventum) was Weedon near Daventry. (ad Antonin. Iter Britann. VI. and VIII. See also Horsley Britann. Roman. III. 2. p. 436.) This is in the right direction, being about north of Allchester; and the straight line thither would pass nearly through Brackley. Camden thought that Stony Stratford might be Isannavaria. Cattieuchlan. (Bedfordshire.)

[f] Item via quæ ducit ad Portam Prætoriam (a Prætorio sine dubio via Prætoria dicitur) latitudine, ut supra, pedum sexaginta. Hygin. de Castramet.

but small portions of it have been removed in some places. In Stukely's time it seems to have been larger; for he describes it as having been "[g] elevated into a ridg of a hundred foot bredth, and two little ditches all along the sides[h]." This was when much of this country was not enclosed: there are no ditches now, and the road has plainly been dug through and carried away every here and there. When opened in a part near Allchester, it was found to be made of broken stones laid on a bed of black mould. The bed of stones may be found in any part by thrusting a stick a few inches into the turf on it: but probably the greater part of the stones which covered it have been removed, even where they are most abundant: for it has been used as a stone-quarry by the farmers of the neighbourhood in more than one place.

Merton is about two miles south of Allchester; and beyond this point the road has now disappeared from the surface for some distance. But following the same course, it is found again at a stony ford over a small brook, by the quantity of stones in the clay both in the bank and at the bottom[i]. And immediately afterwards the place of it appears again in the name of Strettle (Street hill)[k], just across the brook to the south. From hence, as it

[g] Iter II. p. 38. ed. 1724.

[h] This seems to have been common. Horsley says, "circumstances incline me to think that the more ancient military ways were high raised and well trenched on each side to keep them dry." Britann. Rom. I. 8. p. 121.

[i] Stukely describes it in his time as "making fords over the brooks." Ibid.

[k] Horsley Britann. Roman. III. 2. p. 391.

passes to the west of Fencot, there is no ridge or bank visible to mark it; but the course may still be indistinctly traced on the surface at intervals by the stones spread about; which, although they have been removed from their original position, yet indicate that the road was near.

But after crossing the second lane from Fencot, about three miles from Allchester, the line is not only visible and open, but is still a road, known by the country people as *the Roman road*, crossing Otmoor to Beckley. There is about a mile and a half of it here in the moor, part of which is still plainly raised above the level of the ground on each side, and covered with a firm layer of stones. In other places the stones have been removed, and may be seen scattered about in great numbers lying near the road. It is said by the country people that all the stones visible in this part were taken from the Roman road, none having been brought down from a distance since.

The road then leaves Otmoor for Beckley, not by the present road (which at Beckley is called the Otmoor lane), but passing through the field to the left of the lane, and more nearly in a straight line with the road through the moor than the lane is, (for the lane bends to the westward at the gate which comes out of the moor,) it runs along nearly parallel to the lane, about from thirty to twenty yards distant to the eastward from the hedge of the lane[1]. In this part stones are turned up in the

[1] This field in which the old road is now found was enclosed before the rest of Otmoor; and in consequence the thoroughfare of the old road was stopped in this part, and the way out of the

drains in the field, or by digging about a foot deep. A little farther on, the old road falls into the present lane, coming out of the field just described at the gate by which it is entered from the lane. It then crosses the lane in a slanting direction, and soon afterwards appears on the right hand or western side, at first near to the hedge, but gradually diverging into the fields on that side, until the turns of the lane, as it approaches the village, bring the two roads nearer together again. In these fields the old road may be plainly traced on the ploughed ground by the stones, which although broken up and loosened, so that there is no longer any thing like pavement, are strewen so thickly in one line on the clayey stoneless soil, that scarcely any beholder could fail to perceive the evidence which they give. Even above the ploughed fields, where the land is now in pasture, the stones are visible enough on the ground to shew the line farther in ascending the hill. At the last fence before coming to the first cottages, the old road is thirteen paces from the hedge of the lane: at this distance, in the field next to the cottages, on the south side of the fence, the layer of stones firmly bedded together is visible at about eight inches underground. This is exactly in a line with the stones scattered in the fields below, and seems plainly to mark the old road. Above this it is not easily traced; for the ground about that part has been all moved. The tradition of the country is

moor turned to that part which was still unenclosed. This accounts for the present lane having left the course of the old road here.

that it passes by some willow trees which stand out in the field near the cottages. Thence it must have gone through the orchards behind the cottages gradually ascending the hollow: the exact line of it there is not to be discerned: but there is much broken stone scattered about, great part of which has the appearance of having been a good deal worn, like stone which has been laid on a used way; and this is the case with all the stone which I have seen found on any part of this line. Near this place are the traces of another piece of road covered likewise with stone. These appeared a few years ago in making a hedge on the left hand, or eastern side, of the present road or lane, near the first cottages on that side: a continued layer of stones was found running from the cottages along the garden hedge; from whence it slants down the hill, across the field, about in a north-west direction, towards the present lane and the old road: it may be found by digging about six or eight inches under the surface; but it is lost before it meets the present road, and cannot be traced on beyond it to the old road. (See A in the map.) It has been conjectured that this was the course of the Roman road: but it is too much out of the straight line. For it would have turned off from the direction which has been plainly traced hitherto, to go half way up the hill at the least accessible part, and then must have turned again and gone round to fall into the cut which leads to the top of the hill. It is more likely that it was a road leading up to some house, whether Roman or English; for Beckley was once a place of importance. On the opposite side of our road here stood the ancient palace, which was the

seat of the chief manor of the honour of St. Walerie, and the favourite residence of the earls of Cornwall in the thirteenth century[m]; the site of which is still marked, as Kennett describes it, by the stone pigeon-house, although it probably will not be so much longer. (See B in the map.) And foundations of buildings are still found in digging around here. So that there might very probably have been either dwellings, to which this branch of a road led, or fortifications commanding the passage from the valley up the hill. It is possible that there might have been a Roman settlement here, for there were many such in the neighbourhood.

The road goes out of Beckley by a deep cut through the hill, to the south of the village at the eastern end, near where the lane turns out of the street by the pond. The actual line of the road passes along the deepest part of the cut through a garden and premises of a house; but a few yards above this a gate opens from the lane into a bridle-way through a hollow, which hollow is the line of the road, and which emerges through a narrow notch in the limestone rock into the level field above. This cut is remarkable, both because it shews how the Romans carried a road over a steep hill, and also because it still preserves, apparently, the original dimensions: the narrowest part of the cut may be supposed to be the breadth of the old way, that is, about wide enough for a modern waggon: which was probably a considerable width for a Roman road; and is wider than some of the streets in Pompeii.

[m] White Kennett, Parochial Antiq. vol. i. p. 416. 509. 512. Oxf. 1818.

Hence the road passes (used as a bridle-way now) across the road which leads to the New Inn, into the field on the other side, then skirts the eastern end of Stow Wood, and comes out again by the public house, the Royal Oak, on the road from Wheatley to Islip (the old Worcester road) just opposite to the stone which marks the boundary of Stow Wood. For a few yards of the part which skirts the wood, the road seems even now to keep the original form and structure. It is there a high ridge covered with a compact coat of rough stones of unequal sizes, irregularly laid, but firmly packed together, and apparently much worn. (See C in the map.)

After crossing the Islip road the old line is to be traced through ploughed fields. The direction is easily marked: for from the rising ground at the end of Stow Wood the continuation of the road ascending the hill towards Headington Quarries from Bayswater is plainly seen, and the straight line to that point is the course of the Roman Road. If followed in this direction it is to be found at first in the hedge-rows: but a little farther on it becomes very perceptible in the form of a slight ridge running across several fields. It falls into the road from Beckley to Oxford again, near the turning off to Stanton St. John, at a gate opening into a field, on the top of the hill, where stone has been dug; and the course of it across that field may plainly be seen by a person looking from that gate towards Stow Wood. The ridge runs across the field in that direction to a stile[n].

[n] Mr. Wilson has been so good as to furnish me with the following notice of the grounds through which it passes after

From hence it runs in the line of the turnpike road, down the hill by Stafford's (Stane-ford's [o], the farm on the right) to Bayswater (Bayard's water), and ascends again. But towards the top of the hill the turnpike road turns away from it to the west, and it appears in the field on the left (east) side of the present road: there it passes through the corner of an enclosure, and comes into the Wycombe road at a large white gate, through which is the entrance to the cottage close by, called Sandhill. It is very conspicuous where it crosses the Wycombe road, being marked by a high ridge in the bank of the hedge, exactly opposite the white gate just mentioned; at which ridge it enters the field called the Quarry field. The rising of the ground is very visible for some distance in the field, and is thickly covered with loose stones. Farther on, the ground has been levelled by ploughing; but on the opposite side of the field, in the same line, the ridge is seen again, standing up conspicuously in the hedge.

To the south of the quarry field the soil has been all moved in the line of the old road, by the quarries and clay-pits, and for about half a mile it is now quite lost. It appears again on the south side of the road which goes up Shotover hill. In the field behind the last brick-ground on the right hand side, just before the beginning of the ascent of

crossing the road from Stow Wood. Upper and Lower Paddock, by the east hedge; Campsfield; enters Stanton St. John parish in Breach Closes, by the south-east hedge; Parr's Plot, where it is very evident by the hedge; Upper Stafford Grove; which is the field last named in the text, adjoining the turnpike road, and crossed by the ridge.

[o] Or perhaps, Stow-ford.

the hill, it may be faintly traced by a line of rising ground, which runs from the north-west corner of the field by the brick-ground, nearly parallel to the west hedge, but slanting a little upwards, towards a gate which enters the wood [p]. This is all which is now visible: but it is not long since it existed here in the original form. It is but about ten years ago that several cart-loads of the stone of which the road was made were removed from this very field, and used in making underground drains [q]. Within the memory of persons now living, the original covering of the road remained also in part of the ground by the quarries. It has been described to me by one who often saw it, as a layer of unequally sized stones, many of them large, roughly packed together: which is much the same kind of thing as is still to be seen at the east end of Stow Wood.

In the wood there is no trace of it to be found, nor onwards, until we come to the south side of the east end of Bullingdon Green. According to the course followed hitherto, it would lead across Bullingdon Green from N. to S., just on the east side of the little watercourse which crosses it: but nothing is visible of it until, on leaving the Green [r], a field-road appears running straight towards Baldon. Where this road first leaves the Green, a few yards

[p] Plot traced it here into the wood, and no farther. Nat. Hist. Oxfordsh. 27.

[q] This I was told by a man who was employed in the work.

[r] There is another faint trace: where the road to Horsepath crosses our line, and is excavated slightly for a short distance, it seems in one spot to have been cut through a bank, or ridge; for just in that place the soil thrown up on the side of the road rises to a higher mound than elsewhere.

to the east of the little water-course, there are indications of a considerable rising or ridge in the ground, as if there had once been a high bank which had been ploughed down: and this character appears again in many places as it is traced onwards.

This field-road is doubtless the line of the Roman road, which after leaving Bullingdon Green passes for a short distance through the open fields, then falls into a lane, and after crossing first the road to Garsington, and next the road to Chiselhampton, where a solitary house stands on the latter [s], enters a gate and falls into the bridle-way through Sandford Brake to Baldon, keeping the same straight course all the way. Between the Chiselhampton road and Sandford Brake the rising of the ground in some parts of the line still indicates that there has been a ridge, and this is generally to be found here a few feet on the right hand side (west) of the present way. In the field nearest to the Brake a good deal of stone is to be seen in the soil, and under the surface; especially where the drains between the ridges of the ploughed land come down, and cross the line of the road [t]. Beyond this it comes into what is

[s] This house is on the border of Cowley parish, which seems to agree with Warton's notice of our road: for he says it skirts the east of Cowley, which is true if he meant the *parish*. But he says, it is then of great height and width for a certain distance, and then suddenly disappears; which description does not at all agree with present appearances. I cannot help suspecting that he mistook for it a road with a bank going southward from the west end of Bullingdon Green, which skirts Cowley *village*, and ends suddenly. This is half a mile too far to the west, if this is what he meant. Specimen of a History of Oxfordshire, p. 55.

[t] From this part "two or three miles north-west of Balden-

called Blackber's lane, which is a broad green drift-way; containing no sign of any ridge or bank. But many stones appear at intervals all along this part; some of considerable size, the natural soil being clay; and it does not appear that stone has been brought there of late: it is probable, therefore, that these were the materials of the Roman Road.

The line emerges from this lane, and crosses the corner of a ploughed field, and then ascends the hill, by a line of trees, to Baldon. The exact course of it would have been in a straight line from the end of Blackber's lane to the trees at the foot of the hill; and it is certainly remarkable, that, supposing this to have been the case, there is nothing like a line of stones to be seen scattered in that direction, as in the fields below Beckley. But when it is known how the stones in the field by the brick-ground under Shotover hill have been removed, (and there is now not the slightest trace of them there,) it need not be matter of surprise that they have been taken away here also; especially as there is the same reason for it. For the ground is a stiff clay, and lies low; and the stones would be very useful for making drains.

At the top of the hill the line falls into the public road (to Nuneham), a few yards to the right of the gate of the bridle-way, as the rising of the ground

heath," Warton thought there was "a diverticular branch" to be traced going off to the westward to Radley, crossing the river and continued beyond it. There is a crooked by-way to Sandford from hence; but I cannot discern any mark of a Roman origin, nor indeed of antiquity, in it. But, by the way, Warton's description does not determine very precisely where we are to look for this "diverticular branch."

shews. It must then have run nearly in the line of the road for a little way, but lying rather on the left side it presently fell into the premises of the cottage where the road to the left hand turns off, ran a few yards down this latter road, and then fell into a narrow dirty lane which has a straight direction to the village of Marsh Baldon. This lane coincides exactly with the line of the road : it is cut deep into the level of the ground, like a road once much used, although now it is disused, and scarcely passable ; and in the wettest parts it has a hard bottom of large stones. It has moreover been long known by tradition as *the Roman Road.*

From the lane (which ends in Marsh Baldon village) the line passes along the road on the east side of the green of the village, until the modern road turns, just at the corner of Baldon Green, to the left, nearly at a right angle. Here the Roman line is lost : it would have gone straight on, probably, through some inclosures of Sir H. Willoughby's ; and then it seems to have bent a little to the left hand, or east, and so slanting off to have fallen into the course of the present road from Baldon to Dorchester across the fields. For nearly the distance of a mile the course of this road turns out of the straight line by a curve to the eastward : it then returns again, and for the rest of the way to Dorchester it has plainly the character of a Roman road, being perfectly straight, and in great part raised with a high ridge, of which the slope reaches several yards into the fields on each side.

It must be confessed there is some uncertainty about the exact course of our road as it leaves Baldon. The evidence for that line which I have

marked just here is only the general direction, and the existence of a modern field-road in part of it. But it is remarkable that the nature of the ground here seems to offer a satisfactory reason for this slight deviation from the precise course. There is a water-course just in the line where the straight course would run; and the course which has been marked avoids this by turning round the head of it, and escapes crossing it at all. Indeed the course seems so contrived as to fall in with the smallest possible number of these drains in crossing over this ground, which is still wet and swampy in many places. And it must be remembered that the surface was in a very different state when the Romans occupied it, from what it is now. What is now a trifling drain might then have caused a considerable bog, and made a serious impediment to the course of a road.

Our road has now been traced from Allchester for sixteen miles to Dorchester, which is well known to have been a Roman station[u]. Whither it led beyond this is uncertain. It might have passed through Wallingford, as the tradition of the country reported it to Camden. Gale denied that Wallingford was a Roman station, because no Roman antiquities had been found there[x]: but other antiquaries since him have ascertained that Roman coins have

[u] Horsley Britann. Roman. II. 3. Leland says of it, "In the closis and feeldes that lye southly on the town that now standith be founde Numismata Romanorum of gold, silver, and brasse." Itiner. vol. ii. fol. 11. ed. Hearne. See also Skelton Antiq. of Oxfordshire, &c.

[x] Gale ad Antonin. Iter Britann. VII.

been found[y]. But Wallingford was not the next station to Dorchester in the Itinerary, which Richard calls Tamesi: for the distance there given is six miles, whereas Wallingford is distant but three. No certain trace of a Roman road leading from Dorchester in any direction which could be called a continuation of that which has been traced hitherto is yet known. The course of the road from Allchester points to Moulsford and Streatley[z], through Satwell and Mackney. The straight line joining these points with Dorchester would pass over the ridge by Brightwell Barrow, to the east of Sinodun Hill (the ancient camp or fortification of earth-work); and there is a farm-way now visible on the ridge, descending on Satwell, about in this direction, by a line where the hill is scarped with a deep cut. This, from the look of it, seems likely enough to have been an ancient road: but there is nothing about it to shew that it was Roman, unless it be the straightness of it, and the coincidence with the other line[a]. I have not examined the

[y] Lysons' Berkshire, Introd. p. 202, &c.

[z] Lysons (Berkshire, p. 201.) refers to a paper read by Dr. Beke, Professor of Modern History at Oxford, to the Society of Antiquaries, Feb. 9. 1804, on the 18th Iter of Richard. I have not seen this, and therefore do not know in how much of what I have here said he may have anticipated me.

[a] If the road went to the south by this line, it passed too far from Sinodun to have any communication with that work, whether camp or town: and I cannot find any trace of a way looking like a Roman way leading off from this to Sinodun. This favours the opinion that it was not a Roman work. Camden says it certainly was, because Roman coins are ploughed up there (Atrebatii, Barkshire). Lysons says they have not been

ground to the south of this. If the road passed here, it might be visible perhaps between Satwell and Cholsey: beyond Cholsey (if it was there) it would probably be the line of the present road.

found there lately (Berksh. Introd.) From the style of the work no one would suppose that the entrenchments of Sinodun were built by the same people who built Allchester: nor does it seem likely that the Romans would have wasted their labour in raising such huge banks, when they could defend a low wall against any enemies in this country. It seems more probable that it was a British city, of which it formed the citadel, while the plain below on the other side of the river, cut off and defended by that remarkable double wall which joins the Isis with the Thames, and so encloses all the ground between them, was the area of the city. This low position, and the confluence of the rivers, might well give the place a name from *Dor* (water): and it is known that the Britons often chose wet ground and marshes for the sites of their cities. On this supposition Dorchester would have been a British city when the Romans invaded the country; and these which we now see might have been the entrenchments which the Romans stormed and took. It is possible that the Romans might have encamped sometimes on Sinodun hill, or occupied it otherwise, which would account for some coins having been found. See Hearne, Roperi Vita Th. Mori &c. p. 258. It should be observed that there is just such another work, except that the banks or walls are more obliterated, about three miles from Sinodun, at Aston Tirrel, near Blewberry; it is called Blewburton (burg-town, i. e. castle-town). These two are so much alike, that it might be supposed they were the work of the same people: but I never heard that Blewburton was thought to be a Roman work, nor that Roman remains have been found near it. It is worth observing too that this is on the line of a branch of the Iknield way, which was probably an old British road (see Lysons as above). I do not know whether Letcombe castle, which is further to the westward on the line of the Iknield (or Ickleton) way, may be another instance of a fortification not Roman: I should conjecture it was of the same origin as the other two, forming one of a line of settlements of the same people.

Streatley would not be much more than six miles from Dorchester in a straight line, and might therefore suit for the Tamesi of Richard. On a conjecture we cannot imagine any place more likely: for here the Iknield way, which led across the island from east to west, crosses the Thames; and thus the Roman street from north to south would intersect it: and the name Streatley is alone strong evidence that a Roman road passed through the place [b].

But we will now return to the other extremity of our line, and give some account of Allchester. There is no need here to go into the question about the origin and meaning of the name. Some have explained it to be Allecti Castra, and supposed that it was built by Allectus in the war against Carausius: some that it was Alauna, one of the stations mentioned in the Itinerary of Ravennas: others that the name was no more than the Ald-ceaster, the "old camp [c]:" Richard of Cirencester, as we have seen, gives it the name of Ælia Castra [d]: and if that

[b] When the cut for the Great Western railway was made, there was found near Streatley the site of a villa, with pavement, and other indications of a Roman origin. It seemed probable from the appearance of the place that this had been destroyed by violence. I was told by a friend who examined it carefully, that it was quite plain that the ground within the enclosure of the villa had been saturated with blood. Concerning the Iknield way, or Ickleton street, or, as it is called now in some parts of the country, the Hackney way, see Lysons, Berkshire, Introd.

[c] See Camden, Plot, Stukely, White Kennett, Dunkin's History of Bicester, Beesley's History of Banbury.

[d] Ælia was a name often given to places by the Romans (as to the town on the site of Jerusalem). In Britain we find Pons Ælii, which Horsley judged to be Newcastle: there were

was the Roman name, it would be most probable that Allchester was derived from it. It stands on the road from Oxford to Bicester, which passes along the northern boundary (wall) of it; and against that part stands the eleventh mile-stone from Oxford. Mr. Brown's drawing of the camp and ground adjacent is made with so great accuracy, that very little description of the present appearance of it is required. It is, as the plan shews, an irregular square of about three hundred and sixty yards. The ridges which mark the outer walls, as well as those in the line of the streets which crossed the camp at right angles, are plainly visible. It is also not difficult to trace certain divisions of the ground, where the different compartments of the camp would have been marked off, as we may suppose; all of which are bounded by straight lines at right angles, or parallel to each other. These are all laid down in the plan with the greatest exactness by Mr. Brown.

Roman coins, fragments of pottery, tessellæ, bricks, stones which might have been used for pavements, bones, and other relics, have been found in immense quantities all over the area of the camp for many years; and they are still often found, although not so numerous as they were some years ago. Mr. Brown dug up two copper coins of Vespasian this last autumn, and two small vases in pieces, of which he found so many, that he joined them together and made nearly two entire vases; besides various other fragments, among which were

also cohors Ælia Classica, and cohors Ælia Dæorum. These titles were probably taken, as Horsley supposed, from the emperor Adrian's name Ælius. Horsl. Brit. Rom. I. 7. p. 104.

pieces of earthenware with different stamps on them, as BIRR—, DAGODUNUS, CUCCII, and another illegible; these were probably the names of the makers. The coins which are to be found there are well known to the country people, among whom they go by the name of "Allchester bits." They are almost all copper, of various ages; beside those of Vespasian, I have seen them bearing the inscriptions of Antoninus, Faustina, Caracalla, Constantinus, &c.

The place was a station on the Akeman street, the great Roman road from London to Bath: and thus the road to Dorchester must have formed a line of communication between the country of the Thames and the valley about Oxford with the great line of posts running to the westward. For the road which intersects Allchester from north to south is the continuation of the road which we have traced to Dorchester: this passes through the middle of the camp, and proceeds northward, the Bicester turnpike road falling into it where it goes out of the north boundary wall. The road which crosses this, passing through the camp from east to west, is a continuation of the line of the Akeman street, which enters Allchester on the east, but is not carried on beyond it to the west: it seems to have turned and gone out of the camp by the road to the north, and then afterwards to have turned again westward, and so to have fallen into the present line of the Akeman street from Chesterton.

For the Akeman street, coming from the eastward over. Blackthorne hill in the line of the present London road to Bicester, turns away from that road at Wretchwick; and passing to the south of the road

through a farm-yard, and thence into a field (not into the lane), crosses the corner of the field, (where the ridge of it is very plain,) then falls into the lane on the south side of the field, slants across this, and is presently found on the other side of it in the ploughed land above the lane, to the south, where the course is very plainly marked by the stones in the soil; then, as the lane bends, it falls into the lane again, which keeps on close under the north side of Gravenhill wood, until it comes down nearly in a straight line on the stream from Bicester at the place called Langford; from whence there is an evident road made of large stones up to the centre of the eastern boundary of Allchester, at (A) in the plan. Thus a line of road is brought from the Akeman street, by a *very slight* deflexion from the former course, into the camp at Allchester. But the western portion of Akeman street runs on in a straight line from Chesterton; so that if the road necessarily came through Allchester, there would have been a considerable turn to the northward again to get to Chesterton. The straight line joining the two portions of the Akeman street, from Wretchwick to Chesterton, would pass half a mile to the north of Allchester. But although Allchester lay thus much out of the direct line of the Akeman street, and although the supposition that this street actually passed through the camp involves the assertion that it made a turn at a right angle to the north, before it resumed the course to the west, yet still it seems probable that it did pass by this crooked line, and that Allchester was actually on the Akeman street. For there does not appear any trace which I can find, on a careful examination of

the surface of the ground, of a line of Roman road between Chesterton and the part of the Akeman street to the north of Gravenhill wood in the direction of Wretchwick. The part of the Bicester road from Allchester as far as Chesterton lane is plainly the line of the Roman road; for it is exactly in the direction of the road through the camp from south to north. Chesterton lane is also probably the line of a Roman road: in cutting a ditch there lately many coins and other Roman relics have been found; there are appearances also of a stony ridge running alongside of the road for some distance, where a space is left between the present road and the hedge on the south side, which might be the ancient way. And the road through Bicester, which turns away from the exact northern direction towards the east at Chesterton lane, is considered a Roman road, and laid down as such beyond Bicester in the Ordnance map. Therefore, upon the whole, it seems likely that the present roads may keep exactly the ancient course where they diverge, the one up Chesterton lane, the other to Bicester; the former being the return to the line of the Akeman street, the other the continuation of our road from Dorchester towards the north. And it may be observed, that there is now to be seen in the bank of the ditch close to the bridge where Chesterton lane turns off, a mass of broken packed and worn stone, which looks very like a portion of an old road. But there is no trace of the road having been carried on beyond this in the straight line by which it has been brought so far from Allchester, namely bearing due north. A station so important as Allchester might account for the Akeman street

turning out of the straight line to pass through it: and it was not unusual in Britain for the high roads of the Romans to pass through their camps, or close under the walls. Perhaps too the nature of the ground might be taken into the account as the cause. It seems probable that the line from Gravenhill wood through Allchester would have been the easiest ford across the marsh: near to Bicester there would have been two or three streams to cross, or the valley might have been more swampy in other parts than here. I am happy to have this opinion confirmed by Mr. Brown, who writes thus: "It (the Akeman street) *must* have come down to the *ford* (Langford), and either into Allchester or along the lane; then, making a bend towards Bicester, have turned again into Chesterton lane. You will see by my sketch that the whole course of the stream above the ford is now flooded. There is no raised ground, nor any sign of *hard* ground: the stream is deep, and the meadows like bog."

Other lines of road have been observed diverging from the neighbourhood of Allchester. Kennet mentions one going off from the Akeman street, near Chesterton, to the north-west to Middleton Stoney; and another on the east side of the brook, which comes from Bicester, and on the north side of Gravenhill wood, passing to the north-east through Launton. It has also been supposed that the road leading to the south-east from the point in the Akeman street, where it crosses the Bicester brook at Langford, which passes between Merton and Ambrosden towards Boarstall, was a Roman road.

On comparing the area of Allchester with a plan of a Roman camp, the resemblance is evident. For

this purpose I have made a copy of Schelius' plan of a camp from Hyginus, reduced to about the same scale as Mr. Brown's drawing of Allchester, that they might be examined together. From this it appears, that the Akeman street entered the camp at the Porta Principalis (A in the plan) on the east, a little to the north of the middle of the east side, and formed the Via Principalis (A, B) within the camp; that our road from Dorchester entered the camp at the Porta Decumana (M) (so called from the tenth cohorts always stationed there[d]), and passed through it as the Via Prætoria, going out again at the Porta Prætoria (P) to the north, which was next to the enemy[e]. At the crossing of these two roads was the Groma (C), the centre by which the distances of the parts of the camp were regulated, and from which the Scriptores Gromatici, the writers on camp measurements, were so called[f]. The rising ground in the form of a ridge (Q, R), parallel to the Via Principalis, and to the south of it, seems to mark the place of the Via Quintana. The distance (C, Q) between these two roads was the length of the Latus Prætorii: and the other ridges (S, T) between them, on the west side of the Via Prætoria, may indicate a part of the inclosures of the Prætorium, and the quarters of the Comites Imperatoris, or of the Equites Prætoriani.

The size of the camp at Allchester, compared with Hyginus' dimensions of a camp for three legions and their supplements, shews that it was not designed for a very large army. If three legions and their supplements occupied an area of about 770

[d] Hyginus. [e] Porta Prætoria semper hostem spectare debet. Hygin. ad finem. [f] Ibid.

yards by 540[g], Allchester, which is but a square of about 360 yards, could not have held more than one legion. General Roy calculated that the camp of a single legion, without the allies, according to the system of Polybius, would have occupied nearly as large a space: and he has described several Roman camps considerably larger in the north of Britain[h]. The number of men in the legion varied. Polybius speaks of it as either 4000 or 5000 foot[i], beside 200 or 300 horse, according to circumstances: to which the Socii added generally an equal number of foot[j], and three times as many horse; but sometimes even more than this[k]. Livy mentions legions of 6200 foot and 300 horse[l]. According to this, a legion with the supplementa might have contained 10,000 foot and 1200 horse, and upwards: to which must

[g] When Hyginus describes the shape of a camp (as "tertiata"), he gives for an example one whose sides shall be 2400 feet by 1600: this, reckoned in yards (of Roman feet), would be 800 by 533. It is probable that he intended here to give the dimensions of the camp for three legions, which he often speaks of elsewhere as if it were a kind of standard measure by which to describe others. Elsewhere he computes 720 feet, or 240 yards, as the greatest length of the "latus Prætorii," which in Allchester seems to have been about 150 yards; and it there bears a larger proportion, apparently, to the other parts than in Hyginus' camp. I have taken my measure from Schelius' plan, which is accurate enough for the present purpose.

[h] Military Antiquities of the Romans in Britain.

[i] VI. 32. 1. [j] VI. 26. 7.

[k] VI. 32. 3. III. 72. 12. The numbers of the different divisions in the Roman army seem to have been often changed. Josephus says, in speaking of Titus' army at Cæsarea, that out of twenty-three cohorts ten contained 1000 foot each, the remaining thirteen each 600 foot and 120 horse. Bell. Judaic. III. 4. 2.

[l] XXIX. 24.

be added camp followers and attendants in proportion. It is remarkable that the camp at Allchester, while it seems plainly to resemble the camp of Hyginus in the divisions and arrangement of the spaces within, is more like the camp of Polybius in shape[m]; for the latter describes the Roman camp as square[n], the former as an oblong, which he calls *tertiata*, that is, having the sides of the parallelogram to each other as three to two.

The concurrence of many roads at Allchester leads to the consideration of the question, to what extent had the Romans formed a settlement here? The received opinion of antiquaries, and the tradition of the country lately has been, that Allchester was *a large city*. Greatness is a relative idea; but the opinion of the importance of Allchester is somewhat lowered when we see the dimensions assigned by Hyginus. If a Roman camp for only three legions covered an area of more than 400,000 square yards, Allchester would seem to have been less considerable than some have supposed: at least it could not have contained a civic population besides the troops, nor have been a camp and a city too, which they would consider it to be who call the buildings around it "suburbs." But yet a station of this size might have been important enough to form a centre for many converging lines of road, whether there was a city or not. The bends in the course of the Akeman street, the turning of it up to the north to Chesterton, after it comes out of Allchester, and before it falls again into the straight westerly course, would seem indeed to indicate that there was some

[m] On this subject see Gen. Roy Milit. Antiq. [n] VI. 31. 10.

settlement at Chesterton, rather than at Allchester: unless we suppose that it was carried to the northward there for the sake of finding an easier line for a road to the west than there was from Allchester direct. Camden, in whose time many relics must have been visible which have since been removed, notices Allchester as *desertæ stationis antiquæ paucæ reliquiæ* merely. On the other hand, Mr. Brown has found traces of foundations of buildings not only in the meadow to the west, where the site of what is called the castle has been always conspicuous, but also to the north. But indeed it can hardly be thought that there were not settlements formed around Allchester. So large a body of persons as the camp contained would have drawn together many households for safety and for traffic. Since there were certainly many Roman residences in different parts of the neighbourhood, it is likely some were near the head quarters of the district. Thus there might have been houses, villas, or hamlets around the camp. But as yet there seems not to be proof of the existence of a city. No foundations of walls of solid masonry have been found yet, such as would have been suited for the protection of a city, nor any inscriptions. Stukely, indeed, conjectured that the building, of which the foundation is known and marked in the plan by the name of "the Castle," might have been a temple; but no evidence of this has yet appeared[o].

It remains to speak of some other Roman works, which may be considered as connected with our line of road from Allchester to Dorchester; namely,

[o] This was opened at the end of the last century: walls were found, paved floors, and hypocausts. See an account of it in Dunkin's History of Bicester.

another road to the westward, and some stations or settlements in the neighbourhood. This road was first discovered by Plot, who traced part of it, where it was more visible (as it seems) than it now is: but he did not find out whence or whither it led, but only that it disappeared suddenly: and the course and direction of it are still as much a mystery as in his time. Indeed, so little certainty is there about it, that it can hardly be proved that the portions of the line which have been observed are really parts of the same road. I will mention these as they occur, beginning at the north. On the north side of Noke, in a field of Mr. Rogers' farm (called the Upper Log), there is one line across the field, lying about north-west and south-east, in which the corn is observed to be always better than in any other part, more forward in the spring, and better in the crop. In the same straight line, to the south-east, at the corner of the field called the New Ground, in cutting a ditch, the workmen came to a bed of stone, such as would have been laid on a Roman road. The coincidence of this apparent construction of a road with the line in the corn across the adjoining field, seemed to indicate that it was the line of a road. (See L in the map.) There was no cause known for the line in the corn, and the supposition of a road might account for it. At present there is no other trace of the road in this part, nor any trace of it beyond in either direction. But it seems that there was some part of the road still entire in Plot's time, for he says of a road (which led, as he supposed, from Allchester to Oxford), "there is a part still remaining about Noke, whence it passes through the fields to the purlue grounds where it cuts the

Worcester road, (the present Islip road,) and so into Drunshil [p]." If this was the course of it, it must have bent considerably to the south-west in going from this spot near Noke to the Islip road: however, there is no trace of it there, that I can discover, now [q]. It is supposed to have passed through the fields called the Purlieu, and to have come into the Islip high-road, near where there is a small barn lately built by Major Weyland; indeed this barn stands on the supposed line. It then followed the line of the present high-road towards the corner of Stow-Wood, and here there are traces of it: for it is plain that an ancient road passed along the piece of rushy grass on the east side of the road in the low ground before ascending the hill towards Stow-Wood. There are in this part three small water-courses running across the rushy ground at intervals, and each of these has an arch of stone of very solid masonry built over it. The work is certainly ancient, and is supposed to be Roman: it is evident that it was a road; and as the ground begins to rise towards Stow-Wood, the old road may be plainly still seen, bending away from the line in which the arches are seen, and turning into the modern road. It seems probable that it crossed the line of the present road aslant, and went up the hill by a little hollow, where the ground seems to have been slightly dug away, and so crossed the

[p] Nat. Hist. Oxfordsh. 31.

[q] Warton indeed says, "I have traced a ridged way from Noke by Wood Eaton, bearing to Elsfield, and thence cutting the Worcester road." Specimen of Hist. Oxfordsh. p. 57. note. This vague description marks nothing of the place. But there is no trusting Warton's account of what he thought he saw.

present road to Elsfield, a few hundred yards from the corner of Stow-Wood. For a road is found again in an unquestionable form on the other side of the Elsfield road, leading in the direction of Headington. In the first field next to the Elsfield road there is no sign of it; but beyond that there is a very plain ridge of considerable width, in a straight line diagonal to the field, having every appearance of a high bank which has been gradually levelled by the plough, and on and about which there are many stones scattered. Beyond this again it is still plainer: for here it seems to have been the boundary-line between Elsfield and Stow-Wood parishes, in consequence of which a trench has been dug along the Elsfield side of it, and the earth thrown up on the road; so that it forms a very high bank, which is now covered with wood. (See M in the map.) The stone covering of the road may be felt anywhere in this bank by boring a little distance into it; and at the south end of it, where it is cut by a hedge and ditch, the construction of it may be plainly seen: it has been regularly coated with a layer of flattish stones packed together, like the part of the Dorchester road at the east end of Stow-Wood: but here it vanishes suddenly. Plot saw this road; and it is remarkable that some part of it was "paved" in his time very near to Stow-Wood, which is not the case now. But he had not observed the old road between this line and the direction of Noke, namely, the part where the three stone arches are to be seen by the side of the Islip road; neither did he intimate that this line was connected with that by Noke, but he lays them down in his map as running in different directions, nearly at right

angles to each other; and in that part which lies on the confines of Elsfield and Stow-Wood parishes, he seems to have mistaken the trench by the side of the road for the road. In Plot's time, too, it seems to have ended at the same point, and as suddenly as it does at present: there is small hope therefore of recovering it now. The line of it, taken across the two fields where it is now visible, points, as Plot described it, straight to Headington, a little to the westward of the church: but there is no trace of a road on any part of the ground in this line. Neither has it ever been discovered in any other direction, by which it might have turned, either to join the Dorchester road, or to go elsewhere. Yet this fragment which remains has not only the most evident features of a Roman road, but also seems to have been of a large size in breadth and height, quite equal in these respects to the Dorchester and Allchester road; nevertheless it cannot be found for a space long enough to shew to what places it led, whether it was a branch of any other, or what the general bearing of the course was.

Where there is not enough left of the ancient road to judge from the construction or the course of it that it was a Roman work, the next best evidence to this point is the existence of Roman relics in the neighbourhood, indicating that the Romans lived there. Many of these have been found, and are still found about the lines of road which have been described. I will mention such as I have been able to get information of, beginning with those to the north, next to the Allchester end of the line.

About twenty-three years ago a Roman pottery was found in Otmoor in cutting a drain near Fencot.

The spot is in the meadows between the Roman road and Fencot, about a quarter of a mile, or rather more, from the former, on the east, and three fields distant on the south from the lane going (from Charlton) to Fencot. (See D in the map.) A great quantity of broken pottery of all kinds was dug up here in making the cut; but I have not heard of any thing especially curious, except that on one fragment there was the inscription JURE URO: which proves that the Romans took the control of the trade into their own hands, and gave patents or licenses for exercising it; and we may suppose that they did not fail to derive some profit from the permission or privilege granted [a].

There is one remarkable circumstance relating to this pottery. A few years before it was discovered, a brickmaker was brought from a distance on speculation into Otmoor, to try the clay there for making bricks; and if he found it good enough, it was intended that he should establish a business there. After making many trials in other parts of the moor, he at last ascertained that the best clay of all was just *on this very spot*, and accordingly he made preparation for fixing his abode there, and carrying on his work. Some circumstances made this inconvenient, and he was in consequence obliged to move, and settle himself a little way to the westward, very near the Roman road; but being dissatisfied with this, he gave up the scheme and went away. Soon afterwards it was found, on the discovery of the pottery, that the Romans had been

[a] We may also infer from this that the stamps on the pottery (see p. 22.) were probably the names of the persons to whom the licenses were given.

before him in choosing that ground; they also, as we may suppose, had proved that this spot yielded the best clay in the country.

Oddington lies to the S. W. of this, about a mile to the west of the Roman road; and if there had been a western line of road passing from Allchester in the direction of Oxford, as Plot supposed, it might have passed somewhere near here. At Oddington some very curious relics were found, about the year 1815, at the building of the present Rectory-house: (See E in the map.) In digging up the ground to make the garden, several skeletons were uncovered[o]. At first many bones were taken up piecemeal; but after orders had been given to clear away the earth from them carefully, six or seven were laid bare in a whole state as they had been buried. There were many things remarkable in their condition: they were very slightly covered with earth, not being more than from one to two feet beneath the surface. They were not all together, but dispersed about the ground; and they were not laid in any order or uniform position, but with the heads and the feet pointing in all directions, as it might happen. Some of them had helmets on, and I have heard it said that the mouldering remains of some weapons were found by the side of some of them. One of them had the head of a spear fixed in his body between the lower rib and the hip: it is also said, (but for this the narrator who saw them could not trust his memory with certainty,) that another had a spear-head under his shoulder. They seemed to be the skeletons of very tall and large men: one was said

[o] See also Skelton's Antiq. of Oxfordsh. Ploughly Hundred —Oddington.

to have measured more than six feet from his head to his toes. They were found in no large space of ground in the garden of the Rectory: one of them was lying where the hedge now stands; and it seems very probable that there may be more still in the ground in the field without the garden, beyond the hedge to the south-west. Some portions of the arms found with the bodies were sent to be examined by competent antiquarian authority at the time when they were dug up, and were judged to be *Roman*. There can be little doubt that the Romans traversed this ground, for besides the great road to Dorchester, about a mile distant, and the pottery about twice that distance, (not to mention the possibility of another nearer line of road,) a Roman copper coin was picked up in a field near the place in 1838. But from the manner in which these bodies were buried, it seems plain that they belonged to a party, which, if not defeated and flying, yet thought it most prudent not to stay very long in the neighbourhood of the enemy, to whose courage they had been the victims. For the slight depth at which they were laid would seem to be owing to want of time to dig deeper [p]. The irregularity of their position would lead to the same conclusion: the natural method would have been, we may suppose, to make one pit, or a few large receptacles, for them, or, at least, to have laid them out in some kind of order; but these seem to have been just "dug in" as they might chance to lie. Again, their

[p] The ground where they lay had often been ploughed before they were found, and the workmen who dug them up calculated (and it seemed to be a point which interested them) that the plough must have gone within four or five inches of the bodies.

helmets and all their arms would surely have been taken away and kept by the army to which they belonged, unless they had been hard pressed. If therefore these were Roman soldiers, it seems probable that they might have met with a successful resistance at Oddington, which not only caused them the loss of so many men, but also embarrassed the movements of the body to which they belonged, and forced them to make a hasty retreat. Whether the *enemy* here was the native Briton, or some opposing party of Romans, as that of Allectus, or Carausius, must be a matter of conjecture at present. Other remains also have been found near this spot. The place "called Brismere" is said to be "covered with the debris of Roman pottery, extending from the vicarage [rectory] of Oddington to Charlton." A fragment of an urn from this place, and a piece of a leaden vessel, are now in the Ashmolean Museum [q].

If from Oddington we follow the possible course of the road by the western line to Noke, we have here a trace of Roman intercourse in a coin again. In this very year (1841), in January last, Mr. Wilson picked up in a field at Noke a silver coin of Postumus with the figure of a galley on the reverse.

A little farther on, we come to the site of a considerable Roman settlement at Wood Eaton, in Major Weyland's land, on the hill just above the turning from the Islip road to the village of Wood Eaton. This, which was discovered about thirty-eight years ago, (the ground having been a common before that,) might from the position have been

[q] See Catalogue of Ashm. Mus. Antiq. 164. [Rev. P. Serle, Trinity Coll.]

either a military station or a residence. It is high and airy, on a dry soil, commanding a good view on all sides, in which Allchester is comprehended. (See F in the map.) Traces of buildings appear on the surface, and the materials, stone and brick, are constantly turned up by the plough. Close by is a pond containing good water, which is said never to fail, from which it is supposed that the inhabitants would have been supplied. Many Roman coins have been found on this spot, with pieces of pottery, broken arms, heads of spears and arrows, fibulæ, a broken piece of a thin plate of metal, stamped with the letters—EDO, and other Roman remains. The coins are of different kinds and dates, with inscriptions of Nerva, Trajan, Severus, some which commemorate certain legions, &c. Perhaps it is more likely that this was a military station than a private dwellinghouse: for all that has yet been dug up there does not betoken the building or furniture of a *villa*, and the situation is exactly suited for one of a line of posts, whether in connection with Allchester, or formed independently of that, for communication and defence of the district.

A few hundred yards from this place, on the hill on the opposite side of the small valley through which the road to Wood Eaton passes, is Drunshill, where was another Roman settlement. Plot has recorded that Roman urns were dug up here about fourteen years before he wrote: but he does not seem to have visited the ground himself: neither does any antiquary who has noticed this place since, seem to have done more than repeat his words. The spot is the first hill on the right hand (after passing the road to Wood Eaton), as you come

from Islip towards Stow-Wood, and is just opposite to the stone which marks the end of the Stow-Wood highway; it is the hill where stone is now dug. (See G in the map.) The surface of the ground here is now strewed with small pieces of Roman pottery of different kinds of coarse ware, which perhaps are the remains of those very "urns" of which Plot had been informed. For not only are the fragments very small, but the edges of most of them are rubbed and worn as if they had lain there and been turned over and over again by the plough for generations. But there is another curiosity here: a great number of pieces of iron slag are scattered about the same ground with the pottery, or indeed more plentifully than the pottery. These, when submitted to Dr. Buckland for examination, were pronounced by him to be "slag probably from a Roman smelting work supplied with ore from the iron stone of the lower green sand or shanklin formation on the top of Shotover." This opinion was given by him before he knew whence the specimens came[a]. It is likely that this ore had been brought here to be smelted for the sake of the wood growing near, as it was easier to bring the ore down to the fuel, than the fuel to the ore. Perhaps too the vicinity of this iron work agrees better with the supposition that the settlement on the opposite hill in Major Weyland's ground was a military station, than that it was a private dwelling. These settlements confirm the belief that the road along this line was a Roman work, even in those parts where the construction of it cannot now be seen. Whether this road was, as has been conjectured, a second line from Allchester to Dorchester,

[a] Some of this is now in the Museum.

intended to be used when the road across Otmoor was flooded, may I think be questioned. It is not likely that the Romans would have made a road which would be impassable some part (perhaps a large part) of every winter. If their object had been *only* to avoid the flooded ground, they might have rejoined the main road by a much shorter circuit than was made if the road did go off through Noke, and so round Stow Wood. The most probable explanation which I can offer is, that this road was made before the other line. I imagine it might have been the way from the south to the settlements at Drunshill and Wood Eaton, and probably others beyond that, at an early period; that it was continued perhaps by a circuitous route to the north of Otmoor, avoiding the lowest parts, and keeping the ground which was comparatively firm, on the west. After this, when the camp at Allchester was established, I would conjecture that a shorter and straighter road was made across the wettest part of Otmoor to Beckley, and so under Shotover to Dorchester, which naturally, as it was the most direct, became the high road from north to south through this part of the country; and the other line was in some degree superseded. Perhaps this supposition may in part account for the disappearance of this road; if the other had made it less wanted, it might have been less carefully kept up in some parts, and so have perished sooner.

To return then to the direct road from Allchester to Dorchester; at Woodperry house, the residence of Mr. Wilson, evidence of a Roman settlement has been found. At the lower end of his garden great quantities of Roman bricks and tiles, pieces of

pottery, weapons, a leaden weight, coins, and other remains have been dug up. A copper coin of Maximian was found there in January last; and one of Constantine and one of Claudius Gothicus in 1837. Among the weapons are some barbed heads of arrows or spears with very long barbs, of which some specimens have been found at Wood Eaton also; and a small hook with a cutting edge on the inside. The use of this last is not known; it has been supposed that it was a weapon of war for cutting horses' bridles. It *might* be a pruning-hook; or a weapon of the chase, for disabling the game by cutting the sinews of the legs. Perhaps too the long barbed arrows were for the chase, intended to serve for disabling the game from escaping when wounded. It is remarkable that an arrow head of bone, elaborately ornamented with lines carved on it, was found here also: for this must be supposed to have been a British, rather than a Roman weapon.

Southward of this I have not learnt that any Roman relics have been found near the road, until we come to Baldon. By an enclosure there, called *the old hop garden*, near to what used to be Baldon heath, (see K in the map,) some coins were dug up in the year 1796 or 1797[r]. Among those which I have seen, which are now in the possession of the Rev. John Griffith, fellow of Wadham college, (to whose kindness I am indebted for the use of them, as well as for the knowledge of the fact,) I found the inscriptions of Claudius (11, Gothicus), Constantine, and Magnentius. The Roman remains found at Dorchester have already been noticed. The

[r] I was told by an old inhabitant that he *thought he had heard* of urns having been dug up there also.

coins of that place are well known, and at least one valuable collection of them has been made.

There remains but one more point to notice; this is, a small portion of an ancient road near Oxford, which has been called Roman, although there is no proof that it was so. It is to be seen in the field adjoining Marston lane, through which the footpath goes up to (the back of) Headington hill; a few yards from Marston lane, in ascending this footpath, just where there is a small pond, by the rails of the footpath, the road appears, crossing the corner of the field, and running down to the lane, of which it meets the hedge exactly where the stone stands which marks the liberty of the city. If from this pond the eye be turned in the contrary direction, the line may be seen continued on the other side of the hedge, in the field below Mr. Morrell's house, in the direction of the end of China lane. The form of the road is still preserved, apparently unchanged, in the lower field, between the footpath and Marston lane: it is there a distinct ridge, made of a compact bed of rather large irregularly-shaped stones[s]. Plot noticed this line[t], and thought that it was a branch which turned off to Oxford from the Roman road which led from Elsfield to Headington (of which a part appears between Elsfield and Stow-Wood). At present there is no proof of this: neither could Plot trace either of these two branches up to the point where he supposed they met, Headington hill. From the direction of the

[s] I am indebted to the Camden Professor of History for pointing out this fragment to me.

[t] Nat. Hist. Oxfordsh. 30.

few yards of the old road now visible by Marston lane, it might perhaps be thought that it was the continuation of the old London road from Oxford, which formerly passed over Shotover, by the way now called China lane, which turns off in the middle of Headington hill, and to which the old road below would seem to lead[u]: but the construction of it would certainly agree well with the supposition that it is a Roman work.

Plot says little about this, but that it "by its pointing shews as if it once passed the river above Holywell church, straight upon St. Giles's[x]." Warton thought that he traced it much further[y]. The small piece of it which is now visible, points, not at Holywell church, but considerably to the north

[u] Plot thought that the present London road up Headington hill was the line of the Roman road, that the road was originally excavated by the Romans. Wood followed him in this, and thought that the Roman roads met on the top of the hill, one coming up the present hollow (London) road, the other by Joe Pullen's tree. Wood's words are, "*there are* evident tracts of a branch of one of the main ways," &c. Peshall's Hist. of the City of Oxford, p. 286.

[x] Nat. Hist. Oxfordsh. 30.

[y] He says, "Another branch of the branches of the Akeman street perceptibly slants from the brow of Shotover hill, near Oxford, down its northern declivity; bisects Marston lane, crosses the Cherwell north of Holywell church, with a stone pavement, is there called King's Swath or Way, goes over St. Giles's field and Port meadow, has an apparent trajectus over the Isis, now called Binsey ford, being a few yards north of Medley grove, runs through Binsey churchyard, in which are the signatures of large buildings, winds up the hill towards the left, where stood the ancient village of Seckworth, and from thence proceeds to Gloucester, or falls into the Akeman street about Witney." Specimen of a Hist. of Oxfordsh. p. 57, note.

of it, above that point in the Cherwell where the streams divide; that is to say, higher up than Parson's Pleasure. And indeed, if it was a road across the river, it is not unlikely that it should have been carried over a part where there is but one stream, rather than over three; which would have been the case if it had gone from King's mill to Holywell church. But it might easily have turned a little, and so passed nearer to the church. However, I can find no trace of it on any part of this ground.

Mr. Skelton thought Plot's assertion correct; and gave as a reason for it, that he had himself "found Roman money, and other relics, in St. Giles's field, in the gravel-pits immediately facing the public house called the Horse and Jockey, which is the exact direction towards the military works on the hills of the Witham estate[z]."

If the chief ford at Oxford, that from which the name was originally derived, was that by Binsey[a], which passes out of Port meadow a little above Medley lock, there might have been a road from Marston lane across St. Giles's field and Port meadow to it, passing quite to the north of the present town of Oxford. Or there might possibly have

[z] Skelton's Antiquities of Oxfordsh. Bullington Hundred. St. Clement's. Note. I am not acquainted with any *Roman* military works on the Wytham estate. There is a mound on the hill which overlooks Ensham bridge, which is artificial, and was probably a military work, but not Roman, as I should think. And there was a Saxon castle at Wytham, and perhaps entrenchments at Seckworth. See Hearne Lib. Nig. Scaccar. Append. X. XI.

[a] Hearne Lib. Nig. Scaccar. Append. X. 18.

been a road in that line to serve as a way to the holy spring at Binsey; or to the neighbouring village of Seckworth: but these are mere conjectures at present. If there had been any evidence of such a road in Plot's time, it is likely that he would have noticed it[b].

The antiquities of Binsey are described in full by Wood[c]. St. Margaret's well (which, according to Wood, was once called St. Frideswide's), famous for the cures which it wrought, was a few feet to the west of the present church. The stone steps leading down to it were dug up not many years ago, and were in existence within the memory of persons now living[d]. A few yards from the church, on the south-west, in the ditch of the field adjoining the church-yard, there is a bed of large stones, much worn; which must either have been part of an ancient road which passed over there, or else must have been brought from some old road or building; more probably the former.

For it is in this direction that the ancient Saxon village of Seckworth[e] lay, which is said to have

[b] Wood says, "there is a place that is called the King's Swarth, which goes down by Buller's *non ultra* (north of the Parks), and soe over the river, which is called the King's Swarth ford. It is paved at the bottom with stone. This way, as is reported, led from Beaumont's to the King's house at Ellesfield." Hearne ibid. XI.

[c] Hearne ibid. and Peshall. Hist. of the City of Oxford, p. 320.

[d] This fact I have from Dr. Cramer, Principal of New Inn Hall, and Public Orator, the present curate of Binsey.

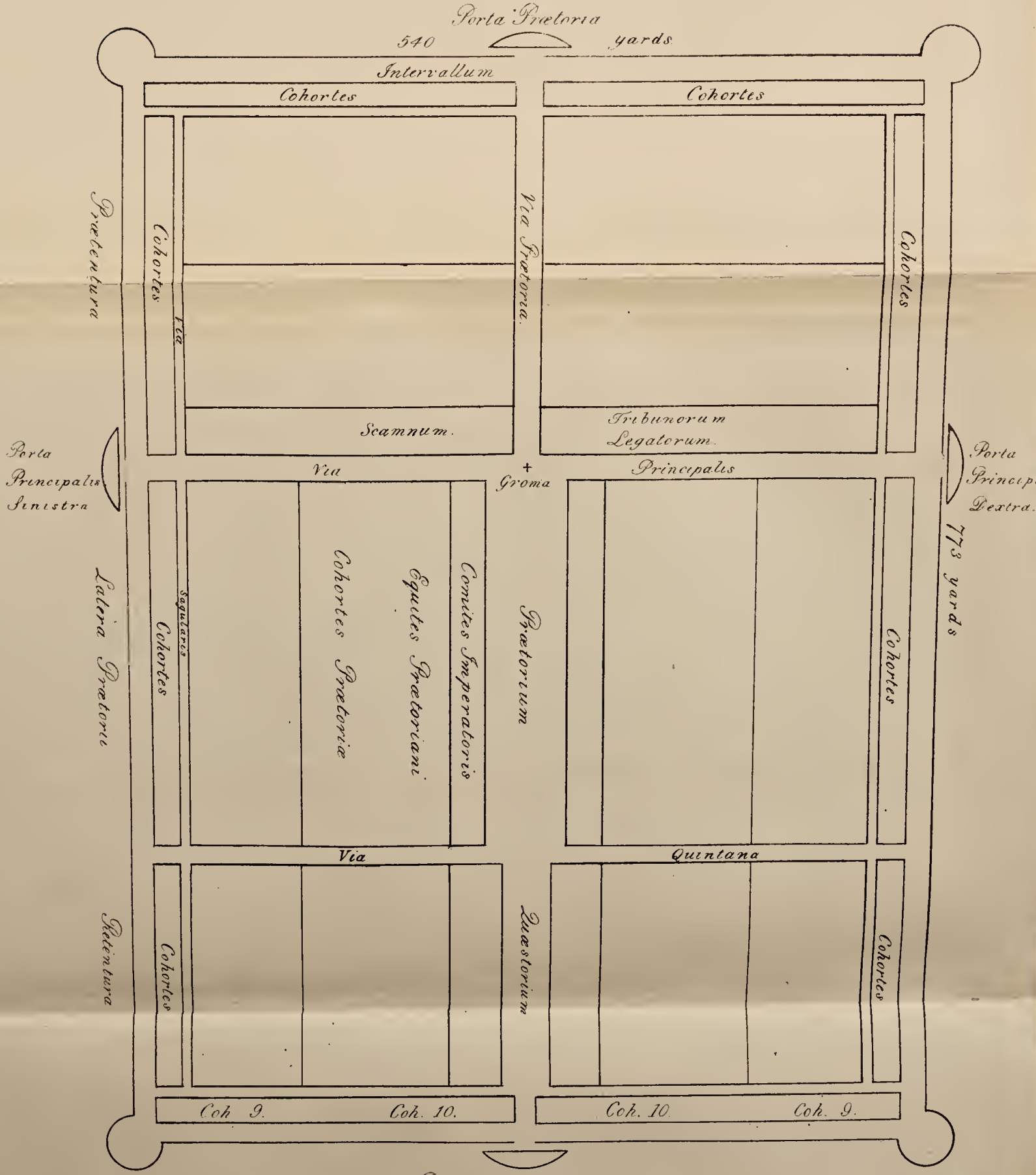
[e] See Hearne and Peshall, ibid. The parish clerk of Binsey (who is now a very old man) says, that his mother remembered two of the houses of the village of Seckworth standing.

become a great and rich place, from the resort of pilgrims to St. Margaret's well. It was on the other side of the stream which flows from Wytham, on the rising ground which slopes from the water towards lord Abingdon's woods, about a quarter of a mile to the south-west from Binsey, with which it was connected by a bridge. And in Wood's time, it seems there was abundance of stones from the ruins scattered about the fields and in the river. The tradition then preserved among the people of Binsey was, that there had once been more than twenty inns in Seckworth. When it flourished thus it was the great thoroughfare from Oxford westward, the causeway by Botley not having been yet made. The memory of the place is still preserved in the name of the farm on the north side of the Ensham road, at the turn from Botley towards Wytham; and although there is now little evidence of Seckworth to be found on the surface, except here and there a large stone, much worn, and the inequalities of the ground, there is still a good deal remaining but a little way below. In the third field from the gate by lord Abingdon's lodge, on the way to Wytham village, where the cowshed stands, there are still large foundations under the surface, which have been found in digging: and the ground here is remarkable for the goodness of the soil, and the grass which grows on it; the quality being superior to that of any ground near it. In a line (not quite straight) from this point to the village of Binsey, (not to the church,) the ancient road still exists, about eight inches under ground. It is now described by those who have found it in digging, as

a hard stoned way, about five or six yards wide [f]. The fishermen also say that they can find the stones of the old bridge still in the bed of the river; but these are not visible to all observers. The tradition of the place still remains: the country people say that Seckworth farm has the name from "the old city which stood between that and Wytham."

[f] This proves how such things sink into the ground, and the ground rises and accumulates over them, and so they are entirely buried in the course of ages. There is no trace whatever of this road on the surface now: and yet it seems that not a stone has been removed from it.

Castra Trium Legionum cum Supplementis



A Roman Camp for three Legions according to Hyginus, reduced to the Scale of the annexed Plan of Allchester from Scheltius' Annotations on Hyginus.

MAP shewing the ROMAN ROAD

from

ALLCHESTER to DORCHESTER,

With other ROMAN REMAINS in the

Neighbourhood.

Explanation of the signs and references

Roman Road still used as a road.

Roman Road where visible but no longer used as a road

Supposed line of Roman Road.

A. *Part of an old road diverging at Beckley. Page 9*

B. *Site of Beckley Palace. P 10.*

C. *Roman Road in the original form. P 11*

D *Roman Pottery near Fencot. P 34*

E. *Ground where the Skeletons were found at Oddington P 35*

F. *Roman Settlement at Wood Eaton P 36*

G *Drunshill, Roman Smelting Works P 36.*

H. *Roman Settlement at Woodperry House P 40*

K *Place where Roman Coins were found at Baldon P 41*

L. *Supposed line of Roman Road near Noke P 30*

M *Part of Roman Road between Stow Wood and Elsfield P 32*

Scale One Inch to a Mile

(Taken from the Ordnance Map)

MAP of the United States, one of the CANADAS.

English Miles.

50 100 150 250

Mouths of the Mississippi River

REMARKS

ON THE

PROPORTIONATE QUANTITIES

OF

RAIN

AT DIFFERENT SEASONS

IN OXFORD.

BY

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ON

THE PROPORTIONATE QUANTITIES OF RAIN AT DIFFERENT SEASONS IN OXFORD.

READ TO THE ASHMOLEAN SOCIETY, MARCH 13, 1835.

THE quantity of rain and the particular seasons of its fall form an essential part of observations in meteorology. The subject is connected with the comforts and convenience of life, and involves the more important considerations of its effects upon the productions of the earth. The state of the atmosphere, which disposes it for the absorption or discharge of moisture may depend on chemical affinities with which we are as yet unacquainted; but the variations in respect to density, electricity, and temperature are well known causes of the phenomena in question. These have their peculiar effects from the relative state of those different parts of the earth's surface with which the air may come into contact, and consequently the weather must always in great measure depend on the quarter from which the wind at the time is blowing. All the other causes here enumerated, if not dependent on, are greatly modified by, heat and cold: between the tropics, therefore, the overwhelming influence of a vertical sun produces in many places a regularity, which we, in higher latitudes, have no opportunity of witnessing. Near the equator, the rainy seasons often return, not only at the same precise times of the year, but nearly with the same degrees of intensity. With us, at a dis-

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	
1815	0.585	0.728	2.027	1.194	2.136	2.060	0.769	1.592	2.448	2.462	0.685	1.943	18.629	1815
1816	2.078	1.242	1.191	1.847	1.357	1.434	4.014	2.261	1.500	2.858	1.695	2.851	24.328	1816
1817	1.693	0.847	1.115	0.144	2.745	2.044	2.563	3.365	0.311	0.654	1.557	2.222	19.260	1817
1818	2.380	1.481	2.499	3.903	2.275	0.193	0.327	0.324	3.654	1.707	3.512	0.822	23.077	1818
1819	1.607	2.449	0.865	1.148	2.725	1.876	1.214	0.566	3.476	1.713	1.545	1.972	21.156	1819
1820	1.879	0.482	0.273	2.115	2.310	0.889	1.691	0.818	1.822	1.885	1.795	1.798	17.757	1820
1821	1.802	0.087	1.876	1.973	1.193	1.130	1.824	3.216	3.407	2.002	3.172	3.428	25.110	1821
1822	0.686	0.942	0.722	2.097	1.487	0.305	3.953	0.120	1.946	2.394	3.506	1.083	19.241	1822
1823	1.360	2.645	1.055	1.873	1.251	1.166	1.861	3.314	2.320	3.470	1.444	2.870	24.629	1823
1824	0.462	2.063	1.558	2 790	1.060	3.070	0.985	3.310	1.914	3.744	3.166	2.527	26.649	1824
1825	0.000	1.362	1.250	1.402	2.594	1.583	0.030	2.977	2.304	2.262	1.528	2.136	19.428	1825
1826	1.147	1.346	1.668	0.964	1.143	0.388	0.705	1.093	3.966	2.516	1.246	1.604	17.786	1826
1827	0.928	0.721	2.007	0.736	1.499	1.508	1.403	1.691	3.262	4.249	1.651	2.574	22.229	1827
1828	2.655	0.817	0.401	2.485	1.841	1.896	3.520	2.674	2.434	2.028	1.041	1.944	23.736	1828
1829	0.547	1.137	0.200	3.326	0.143	2.846	3.620	3.447	2.545	1.459	0.954	0.402	20.626	1829
1830	0.774	1.120	0.331	2.449	3.369	3.194	2.696	3.516	4.058	0.763	1.908	1.129	25.307	1830
1831	2.037	2.046	1.861	1.414	2.065	1.365	3.978	1.787	3.445	2.812	2.032	2.634	27.476	1831
1832	1.347	0.329	1.711	2.089	2.507	2.660	1.417	4.104	0.920	2.944	2.694	1.598	24.320	1832
1833	0.620	3.837	0.971	2.013	0.271	2.263	1.970	1.075	1.152	2.411	1.807	3.109	21.499	1833
1834	2.325	0.442	0.372	0.533	0.981	1.024	6.473	1.760	3.149	0.920	1.208	0.722	19.909	1834
Mean	1.294	1.352	1.241	1.893	1.788	1.677	2.028	2.171	2.468	2.333	1.944	2.034	22.223	19 years.[a]
	1.346	1.306	1.198	1.825	1.748	1.645	2.251	2.150	2.502	2.263	1.907	1.968	22.109	20 years.[b]

[a] From 1815 to 1833.

[b] From 1815 to 1834.

A period of five or even of ten years was found to be insufficient for any general result, but fifteen years began to lead to conclusions which had a certain degree of uniformity, and appeared likely to afford a clew for further investigation. With this view, however, it seemed right to omit the year 1834: it was a most anomalous season; not perhaps so much from the small quantity of rain which fell in it, as from so very large a proportion of the whole having fallen within limited periods. The effect will be shewn that this produces on the general averages, but in the computation of them it has been thought better to confine the attention to the preceding period of nineteen years from 1815 to 1833 inclusive. This will possibly be sufficient for a first approximate induction, and it has the advantage of being the same with the golden number, or Metonic Cycle, at the end of which the new moons return again in succession, so as to coincide with the same days of the several months. There is a general impression that the lunar influence is very great on the state of the weather, and some have even imagined that a knowledge of the moon's phases is sufficient to ascertain what may be expected. This however is certainly assuming too much. Dr. Horsley drew up an abridged state of the weather at London in 1774, in which he speaks with very great hesitation of this alleged agency[a]: and although he found in the following year that the trial, as he says, "turned out more in favour of the moon," still the changes were even then "many more on "the days confessedly exempt from her influence, "than on those which have been supposed to be

[a] Phil. Trans. Vol. LXV. p. 178.

most subject to it[b]." In the collection, however, and arrangement of facts, it is advantageous to have the power of investigating the manner in which they may bear upon this question.

The absolute quantities will not lead to just conclusions without they are considered with reference to the general character of the seasons in which they occur. Thus in June 1824 we had 3.070 inches of rain, and in the same month of 1829 we had 2.846; but the latter is the greater proportionate quantity when compared with the whole of that which fell in those respective years; for, $\frac{3.07}{26.649}=0.115$, and $\frac{2.846}{20.624}=0.138$. To simplify the proportions therefore, the annual totals, or their sums, (when several years are taken together,) have in making comparisons been considered as consisting of 100 parts, so that the numbers used may express for each portion the quantity of these hundredths which may belong to it. If all our months were of equal length, and there were no bissextiles, their mean value would be 8.33, and this will be sufficient for a general estimate: the limits to which the error can extend is not great, the most considerable of course would be for February in a common year, which is only 7.67 of the whole, which does not make a difference of more than 0.66 or $\frac{2}{3}$ of a single hundredth. For a month of thirty days in a leap year the number is 8.20, and for a month of 31 days in a common year, it is 8.49. This however, even if it were more considerable, would not affect the present inquiry, which is only directed to the quantities of rain which fall in

[a] Phil. Trans. Vol. LXVI. p. 363.

each successive month of the civil division of the year.

Before the more general examinations shall be made, it may be useful to consider some of the particulars which are offered by the respective months.

January is the only month in which there has been an instance of no rain having fallen during the nineteen years which have been already specified; and to save repetitions, it may be right to premise, that, unless notice is taken to the contrary, all the conclusions must be understood to be limited to this interval. This remarkable dryness occurred in 1825; and in 1815 and 1824 less rain fell in January than in any other month of the year. In 1828 it gave 11.12 parts of the whole, but this is its maximum; it has not proved the wettest month of the year, and indeed its average is much below the twelfth part of the whole annual fall.

February in 1821 gave only 0.35; and it was then, as might be imagined, the driest month of the year: it was so also in 1827 and 1832. Its average is rather higher than that of January, and it seems liable to greater fluctuations. In 1833 it was the wettest month of the year, its quantity of rain amounting to 17.85 parts. In other years it has been a wet month, though not to the excess of 1833; but after all it cannot claim with us the designation, which it has obtained in some other parts of the country, of February fill-dike.

March again upon the whole has been a dry month: it has indeed been oftener than any other the driest of the year, having proved so in 1816, 1820, 1823, 1828, 1830. It is an old saying that a peck of March dust is worth a king's ransom, and in this re-

spect the season seems favourable to the agriculturists in the district which surrounds us. In no instance has March, although it consists of one and thirty days, brought down more rain than any other month of the year. The extremes have been 0.97 in 1829, and 10.88 in 1815, making a variation of 9.91.

April is usually a month in which short heavy rains, and sometimes hail storms, occur, when in the intervals the sky exhibits bright sunshine. Its average has been higher than that of the preceding months. In 1817 it was the driest of the year, affording only 0.75; and in 1818 it was the wettest, producing 16.91. These are indeed the only instances in which it has been in the extremes of any years, but the variation amounts to 16.16.

The average for May is a little less than that for April. In 1829 it gave only 0.69. In that year, and in 1833, it was the driest month of the year, and in 1820 it was the wettest. In proportion however to the whole of the annual fall the largest quantity of rain fell in May 1817, which gave 14.25. The variation therefore amounts to only 13.56.

June, upon an average, has been one of the drier months, and has in no instance contributed more than any other to the annual fall of rain: it produced less than any in 1818, 1826, and 1831; its extremes have been 0.84 in 1818, and 13.80 in 1829, making a variation of 12.96.

July has certainly been a wet month, though not upon the whole in so large a proportion as seems generally to be believed. In 1825 only 0.15 was produced by it, but it has not been the driest month of any one year. In 1816, 1822, 1828, 1829, 1831, it was the wettest: in 1822 no less than 20.54 fell in

this month; in 1834, however, the quantity was much larger, being 32.51, or nearly $\frac{1}{3}$ of the whole rain which fell in the year. It is this extraordinary quantity in what was, even including it, still a dry year, which seemed to make it advisable not to take such a season into the general account. It appears indeed to have been characteristic of this year, that although the whole rain was considerably below the annual average, yet that when it did fall it was exceedingly heavy. Thus we had in

January	11.68
July	32.51
September	15.82
	60.01

So that no less than $\frac{3}{5}$ of the annual fall took place in these three months, and 48.33, or nearly one half, in the two last. The variation indeed in July has amounted to 20.39, without taking into account the very great fall of 1834.

August, like July, has had more than its proportionate share of the annual rain. In 1822 however it only produced 0.62, and then, as well as in 1819, it was the driest month of the year; but in 1817, 1825, and 1832, it was the wettest, the rain in the first of these years amounting to 17.47. The variation therefore between the extremes was 16.85.

September has been decidedly our wettest month: in no instance has it produced less rain than any other in the same year: its least quantity was 1.61 in 1817; but in 1826 it produced no less than 22.30; and in that year, as well as in 1819 and 1830, it gave more than any other. The difference between

the extremes is 20.69, which is a little more than that in July, when we omit 1834.

October has had the highest average next to September. It has not proved in any instance our driest month, its least proportionate quantity having been 3.01 in 1830; but it was the wettest month of the year in 1827, (when it produced 19,11,) and also in 1815, 1823, 1824. The extremes differ 16.10, which is less than in July and September.

November has produced rather more than a mean quantity of rain; but not by any means to the amount which is commonly imagined. It has not in any year been the extreme month either for drought or wet. The least quantity was 3.68 in 1815, and the largest was 18.22 in 1822, which gives a range of 14.54.

In December the average rises again, and it has once (in 1821) been found in the extreme of humidity for the year; but it has not in any instance been the driest month; the least quantity of rain was 1.95 in 1829, and the greatest 14.46 in 1833; the difference between which quantities is 12.51.

If now the averages of the whole nineteen years are tabulated they will give the following results:

January 5.82	July 9.13
February.....6.08	August 9.77
March 5.58	September...11.10
April 8.52	October 10.50
May.....8.05	November ... 8.75
June 7.55	December ... 9.15

From hence it appears that the three first months, of January, February, and March, have not upon the whole differed much from each other, and have been decidedly the driest of the year, the total rain

which has fallen in them amounting only to 17.48, or little more than $\frac{1}{6}$ of the annual fall. It has been shewn likewise that out of nineteen years, the driest month has occurred three times in January, three in February, and five in March; and there is only one instance (of 1833) in which either of these three has produced more rain than any other of the twelve months.

The next three months, of April, May, and June, again have approached each other, so that they may be classed together, although their mutual differences have been rather greater than those of January, February, and March. They have averaged together 24.12, or rather less than $\frac{1}{4}$ of the whole year. It is found indeed that as we advance, the rain upon the whole has increased, though it is remarkable that the changes are sudden; the difference between March and April is relatively very considerable. After April, the quantity of rain gradually has diminished till the end of June. This is so much the case that we have not had the maximum for the year in this last month, although it has occurred once in April and once in May. On the other hand, the minimum has been three different years in June, twice in May, and once in April.

The quantity has gone on increasing through July, August, and September, and then begun again to diminish. July and August are the months in which thunder storms are most common, and although these are frequently of very limited extent, yet the quantity of rain which falls during their continuance is very great: this will account for the actual quantity at this season often very much exceeding the common average; but it is clear that the three months of August, September, and October have contributed

more than any other equal portion of time to the sum total of the year: the average for them is 31.37, or nearly $\frac{1}{3}$ of the annual fall. July ranks more with November and December, and the sum of the three has been 27.03, or rather more than $\frac{1}{4}$.

Of the nineteen years which we are discussing, July has been the wettest month in five, August and September each in three, and October in four. There are only four single instances in which the greatest fall has been in February, April, May, and December.

The sudden increase from March to April is not found to have been occasioned by the storms which sometimes follow the equinox; and there is a much more remarkable change from the month of December, which has produced rather more than the mean quantity of rain, to the diminished fall which has taken place in January: this would seem to connect the less and greater quantities with the increasing and shortening of the length of the days, and the rain of the first six months has been to that of the last six as 41.60 to 58.40; but on the other hand it is to be noticed, that the relative effects of the sun's influence cannot be the only cause on which these phenomena depend, for the rain has been not only more abundant in April, May, and June, than in January, February, and March, but has diminished in October, November, and December, when the days are gradually approaching to their shortest duration.

This proportion will be sufficient for a division of the year into two nearly equal parts, because the last six months contain only three days more than the first: but there are some sources of uncertainty in endeavouring from our present observations to form

an estimate of the rain which falls in the interval between one of the equinoxes and that which succeeds it. The sun is about eight days longer in passing from the vernal to the autumnal, than it is in returning from the autumnal to the vernal equinox. This might be allowed for; but it is not so easy to ascertain the effect which belongs to the days which intervene between the times of the equinox, and the ends of the months in which it occurs. These intervals, however, are not very different from each other; and if we take the rain which falls from the beginning of April to the end of September, and from the beginning of October to the end of March, the ratio of the one to the other has been as 54.12 to 45.88. If we take the months of the civil year, there are no six in succession which have given exactly the half of the annual rain: the nearest have been from the beginning of March to the end of August, and from the beginning of September to the end of February; but the former has been less than the latter in the ratio of 48.60 to 51.40.

The months arranged according to their relative humidity will give the following proportions:

Fifteen years, 1815-1829	1819-1833	Nineteen years, 1815-1833		Twenty years, 1815-1834
11.53	11.57	September	11.10	11.32
10.94	10.88	October	10.50	10.23
9.51	10.00	August	9.77	9.73
9.32	9.14	December	9.15	8.90
8.81	9.16	July	9.13	10.18
8.80	8.75	November	8.75	8.63
8.65	8.57	April	8.52	8.25
7.96	7.56	May	8.05	7.90
6.92	7.76	June	7.55	7.44
5.67	6.35	February	6.08	5.91
6.12	5.30	January	5.82	6.09
5.78	4.97	March	5.58	5.42

From this table it will be seen that there has been a certain order, which probably is of no casual description; for it obtains in general in the various periods which have been calculated for the results which are here arranged by the side of each other. There are indeed some partial discrepancies in the first three columns, but they are not more than might be expected in the present state of the inquiry. In the first fifteen years the average of November was a little above that of July in the ratio of 8.8052 to 8.7996, but in the second fifteen, and in the longer period of nineteen years, July has the larger quantity. The three first months of the year, though decidedly the driest, have not exactly preserved their relative numbers. March has not in either instance produced so much wet as January; but the fluctuations which have been noticed in February have placed it during different periods above and below the other two.

Although the anomaly of 1834 made it seem right to omit it in taking the general averages, the results of the twenty years have been added in the last column. This may not only be useful in justification of the omission, but may be satisfactory by shewing the extent to which it affects the conclusions. It will shew that no new view is opened by it in the order of the months, but from the dislocation of July, which is raised above August and December. The very circumstance of the differences being so very partial, which has been already explained, formed a reason for not taking it into the present consideration. In a longer period, when similar anomalies may have occurred in other months, this year may again be brought into the general calculation.

From the impossibility of as yet ascertaining each particular cause of change, the inquiry must be exposed to similar difficulties, which may hereafter be the very means of leading to otherwise-unsuspected truths. At first we are only able to take our position on chances, the conclusions from which will very often in particular cases differ widely from the facts, but still are the best means by which we can advance in generalizing our views of natural phenomena.

In consequence of what has been said respecting 1834, it seemed well to subjoin the general results of the observations for that year on the heights of the Barometer and Thermometer.

	Barometer.				Thermometer out of doors.			
	10 BN	2 AN	10 AN	Mean	10 BN	2 AN	10 AN	Mean
January	29.57	29.56	29.57	29.57	45.1	46.7	44.4	45.4
February	29.99	29.98	29.98	29.98	41.8	45.7	39.7	42.4
March	30.08	30.05	30.05	30.06	46.4	50.3	42.1	46.3
April	30.03	30.00	30.01	30.01	49.0	53.1	42.2	48.1
May	29.87	29.89	29.90	29.89	59.7	64.5	51.3	58.5
June	29.87	29.85	29.85	29.86	65.2	68.5	56.2	63.3
July	29.84	29.82	29.83	29.83	66.8	69.9	59.9	65.5
August	29.77	29.76	29.77	29.77	66.0	68.9	57.8	64.2
September	29.95	29.93	29.94	29.94	60.5	65.3	54.3	60.0
October	29.92	29.90	29.92	29.91	53.1	56.9	48.3	52.8
November	29.81	29.78	29.79	29.79	44.8	47.3	41.5	44.5
December	30.16	30.14	30.15	30.15	42.1	44.6	40.3	42.3
Mean	29.91	29.89	29.90	29.90	53.4	56.8	48.2	52.8

Extremes	Barometer	30.49 Dec. 11 and 15.	28.85 Jan. 12.
	Thermometer	82. 8 June 21	24. 2 Dec. 24.

PLAN OF THE GROUND
Containing Remains
of the ROMAN CAMP at
ALLCHESTER.

Drawn by
The Rev.d W L Brown M A
late Student of Christ Church

Stream from CHESTERTON MILL

CHESTERTON LANE

Great accumulation of Road materials along this LANE. It is much raised. Roman Coins, Pottery Bricks &c found in digging a ditch by the Road side

Gravel Pit

Apparent remains of Foundations

a double hedge - ground raised between but no signs of a road - no stone

N B Feb.y 16th 1841
The Water is now standing here and wherever else it is so lined

Apparent Remains of a similar double hedge & ditch

Clements Farm

Coins found

Ground raised stony & irregular & foundations

Pond

Stone x

Ground disturbed

Foundations have been dug up here Ground raised & stony

Remains of a ditch or where the foundations of a Wall have been taken out

Ground raised stony and irregular

Ditch

Double hedge and ditch

XI Miles from Oxford

from OXFORD to BICESTER

LANE to LANGFORD

TURNPIKE ROAD

Foundations of what is commonly called

the "Castle" or "Rutla" Rooms with tessellated and brick Pavements walls some 4 f.t thick Stucco &c found some years ago)

ALLCHESTER

F E B C A S H G T R Q K L M

Straw Yard

Stones

Line of Roman Road to DORCHESTER

Ground raised stony and irregular (AKEMAN STREET)

Fragments of Roman Bricks dug up in under draining the low parts of this Meadow

E GRAVES WOOD

Causeway & Foot Bridge

AKEMAN STREET

Road to Boarstall

Scale of Yards
50 100 200 300 400 500

References to Letters

A Ground opened (in 1840) Foundations of a wall running N & S. on the W. side apparent remains of a stucco or tessellated floor. At bottom loose stones set edgeways. Over these a layer of flat stones. Upon that mortar — Tesselæ found on the E. side of the wall. Bones and fragments of pottery in great abundance also ashes

B At a depth of nearly 7 feet in mortar &c. ... a fine large brass Coin of Vespasian a few stones but no wall

C 4 feet of black mould. Below that rubbish to the level of the water and gravel

E Bones Pottery and ashes

F Gravel 18 in. thick — 9 in. beneath the surface A large Knife found under the Gravel

G In digging the ditch across, Roman Bricks and ashes.

H Rubbish and Gravel.

NB The natural soil here is a clean gritty gravel at 9 or 10 inches below the surface. The highest points in ALLCHESTER are at C K A B G L the highest of these about 8 Feet above the Gravel.

SKETCH

OF THE

GEOLOGY OF NORTH AMERICA,

BEING THE

SUBSTANCE OF A MEMOIR

READ BEFORE THE ASHMOLEAN SOCIETY NOV. 26, 1838.

BY

CHARLES DAUBENY, M.D. F.R.S. L.S. G.S. M.R.I.A.

MEMBER OF THE AMERICAN PHILOSOPHICAL SOCIETY
HELD AT PHILADELPHIA,

OF THE LITERARY AND HISTORICAL SOCIETY OF QUEBEC, &c.

PROFESSOR OF CHEMISTRY, AND OF BOTANY, IN THE
UNIVERSITY OF OXFORD.

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THE ASHMOLEAN SOCIETY.

MDCCCXXXIX.

The Ashmolean Society desire it to be understood that they are not answerable, as a body, for any facts, reasonings, or opinions, advanced in papers printed by them.

TO

THE PRESIDENT AND MEMBERS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT

PHILADELPHIA.

Oxford, August 1, 1839.

GENTLEMEN,

I KNOW not to whom I can more appropriately inscribe the present humble attempt to elucidate the geological structure of that portion of the continent of America from which I have lately returned, than to a Society, in whose prosperity I feel an interest commensurate to the regard I cherish for several of the members that compose it; and which moreover has an additional claim to my sympathy and good wishes, from having conferred upon me the honour of enrolling me amongst the number of its Associates.

Your Society also is one, which, independently of all considerations of a personal nature, demands the consideration of Englishmen, as

the first institution that had sprung up amongst their Transatlantic Brethren, for the express encouragement of science and literature; objects of which you have at no time lost sight, as the names of a Franklin, a Rittenhouse, a Jefferson, and a Du Ponceau, who have successively figured amongst your Presidents, would alone be sufficient to testify.

And it is with renewed pleasure that I am thus led to look back upon a Body, which is associated in my recollections with the good city of Philadelphia—a spot, towards which I had felt favourably disposed, from the history of its first settlement, and the moral qualities of its Founder, even before I had seen them both blazoned forth in the eloquent pages of a living native historian[a]; and one too, which when I at length visited it, not only conciliated my regard by the kind attentions I received from many of its principal citizens, but likewise continued to justify in my estimation, its title to the name of the "City of Brotherly Love," by the munificence of its charitable institutions, the benevolent aim of its prison-discipline, and the general urbanity of its population.

I will also confess, that having experienced the benefit of those ancient collegiate establishments, by the aid of which so many of my own countrymen are enabled to range freely through the domains of science or literature, according as their respective tastes may direct, without being

[a] See Bancroft's History of the United States, vol. ii. ch. 16.

drawn aside from either by the "stern realities of life;" I looked with peculiar complacency and hope on the prospects of your city, as the spot recently selected for an Institution, not less munificently endowed, and I trust not less adapted to minister to the same beneficial purposes.

Others indeed, more imbued with utilitarian principles than I profess to be, may grudge the application of the vast wealth of a Girard to the foundation of a single college; but those who regard the endowment in question, as a fund, by the aid of which a body of men may be induced to devote their lives to the advancement, as well as the dissemination of learning, and to pursue knowledge for its own sake alone, contented to regard it as an end, and not merely as the means of arriving at other objects—such persons, I say, will view this munificent benefaction, as one calculated to diffuse a more elevated tone of feeling around it, and to raise the intellectual character of Philadelphia amongst the cities of the Union.

But the greater reason I have for looking up to the Society, to which the present publication is addressed, the more incumbent do I feel it to be, to apologize for its slender merits.

Had indeed my attention, during my stay in your country, been concentrated on matters connected with Geology, or even with Natural History in general, it is possible I might have collected materials better worth laying before

your Body, than those which I now presume to address to you.

But what Englishman could visit for the first time a land like America, without having his attention from time to time drawn aside from the features of inanimate nature; or without interesting himself in the character and destinies of a race, which in some respects has so much in common with his own, and in others stands in such remarkable contrast to it?

I therefore present the following Sketch of American Geology, as embodying the result of one only out of many inquiries which divided the time of my residence in your country; although when I reflect upon the difficulty and invidiousness of the task I should impose upon myself, were I to attempt to delineate the moral and political condition of your Republic, I feel indisposed to trust myself in print beyond the field embraced by the present Report.

It might not indeed have been difficult for me, to have filled the number of pages requisite for a popular work of travels, by a picture of the peculiarities that lie upon the surface of American society, but regarding the publications of this class which have issued from the British press as disproportionately great already, I felt no inclination to add to their number.

Not, indeed, that I would be understood to join in the outcry, that has been raised in America against the class of writings alluded to. In spite of the exaggerations which they con-

tain, and the prejudices which they undoubtedly display, it is impossible not to perceive, that they have executed for your countrymen an useful, though, I fear, rather a thankless office—one, that in other parts of the civilized world is performed by the popular novelist, or satirist, that the nation itself is sure to supply, but which in yours, like many other tasks which the omnipotence of public opinion obliges native Americans to decline[b], remains open for competitors from another country.

Whilst, however, I give all due credit to the Trollopes, the Hamiltons, and the Maryatts, for having supplied a deficiency, which every one must perceive to exist in your literature, (for your own popular delineators of national manners touch too tenderly upon the foibles and defects which they hint at, to answer the desired end,) I cannot but regret at the same time, that a state of society, at once so novel in its character, so pregnant with important consequences from its influence on other nations, and so

[b] Dr. Channing, though not to be placed with either of the above-mentioned classes of writers, belonging, as he does, to a much higher grade of literature than either, ought nevertheless to be exempted from the remark in my text; for though he evinces in his works a just pride in his title as an American citizen, and disdains to measure the national character by a purely European standard, yet he has on no occasion been withheld from frankly and fearlessly *telling his countrymen the truth*, even on subjects on which they evince the greatest sensitiveness.

See his Letter to Mr. Clay on the Annexation of Texas, a pamphlet not less distinguished for beauty of composition, than for the enlarged and independent views which it develops.

peculiarly interesting to Englishmen, from the affinity subsisting between the people which are experiencing its operation, and their own, should not have been commented upon by British writers in a more philosophical, and, if I may so express myself, a more *catholic* spirit. The common error, indeed, upon which English writers, of whatever politics, have proceeded in treating of your country, appears to be that of regarding the peculiar form of government that happens to prevail amongst you, as if it were competent to furnish a key to all the peculiarities which characterise your race.

Hence those who have brought with them from Europe their aristocratical predilections, seize with avidity on every disadvantageous trait in the American character, as illustrative of the evils of democratic governments; whilst others, in their zeal for republicanism, instead of looking abroad for the cause of such defects as they espy, and searching for them in the circumstances affecting your moral and physical condition in which government has no share, are too apt to set them down at once, as resulting from a remnant of the old leaven of feudality, which, according to them, still lingers in your constitution, and interferes with the proper working of its popular elements.

But there is more true philosophy in the well-known lines of Goldsmith,

> How small, of all that human hearts endure,
> That part, which laws or kings can cause or cure!

for it is certain, that whatever may be the form of government which a country possesses, its spirit is in a great degree determined by the state of society, which causes antecedent to its existence, or at least manifestly independent of its influence, have conspired to bring about.

Thus, nothing is more striking than the difference between the state of manners in the southern, northern, and western portions of the Union, enjoying, as they do, the same democratic institutions; nor is it conceivable, that if the monarchical form of government had maintained its ground to the present day in the newly-peopled states, its existence would have materially lessened that independence of the lower classes of the higher, which seems to be the necessary consequence of the scanty supply of labourers, and of the security against want, which the vast unpeopled regions of the west afford to the meanest of your citizens.

For my own part, were I called upon to offer an opinion upon the American constitution, I should not hesitate to aver, that no other than a democratic form appears, either to be in harmony with the existing state of society, or to be capable of maintaining its ground in a country so circumstanced; but it would be uncandid were I not to add, that the effects which I considered myself warranted in tracing to the operation of the democratic principle were not calculated in general to prepossess me in its favour, or to re-

pursued at the different American Universities with reference to these debated points.

The originators of the London University, for instance, who contended for the impossibility of combining religious instruction with the indiscriminate admission of sects, might have learnt from the case of the University of Virginia, what success had attended the experiment, previously instituted under the auspices of President Jefferson, to establish a system of education wholly unconnected with any form of religious worship.

And on the other hand, those amongst ourselves who contended for the opposite principle, would have done well to inquire, by reference to the Universities of New England, how far such a plan admitted of realization.

Again, the comparative advantages of an endowed, or an unendowed Church, might have been elucidated, by a careful examination of the state of the several religious Denominations existing in America, or of the same Denominations in different parts of the Union, according as it is supported in the one or other of these ways [b].

Such inquiries seem to lie midway between those lofty but often barren speculations, with respect to the political institutions of the United

[b] It is a mistake to suppose that no form of worship in the United States is endowed, because no one is established. The Episcopal Church at New York affords a striking proof of such being the case.

States, in which one class of travellers have indulged, and the familiar portraiture of men and manners which has served as the favourite theme of another.

But, for my own part, whilst I wanted the inclination to associate myself with the latter, I felt too sensibly my own deficiencies, both as to time and information, to think of aspiring to a place amongst the former.

If however my observations on the American character are likely to lead to no results in which the public are interested, they have at least had the good effect of dispelling from my mind many prejudices, and of enabling me to take a more candid and dispassionate view of my brethren on the other side of the Atlantic, than I could otherwise have arrived at.

My experience indeed has not blinded me to the unfavourable influences upon national manners, which arise from that nearer approach to social and political equality existing amongst you, than any other civilised nation hitherto has attained to; and so far from leading me to lament, with certain political enthusiasts of my own country, that the tendency towards this ideal goal of perfection, which your commonwealth has displayed, has been somewhat checked in its downward course by other causes, it has taught me rather to congratulate myself, that such a state of things must, from the very laws of human nature, be ever partial and incomplete.

Neither has it enabled me to look exactly with the eye of national partiality upon a *free-born American*, who, if we were to believe the hyperbolical language of self-flattery,

uno minor est Jove, dives,
Liber, honoratus, pulcher, rex denique regum—

and (with a proviso, the force of which will be appreciated by a tobacco-loving nation,)

Præcipue sanus, nisi cum pituita molesta est.

But seriously, and in good faith, I am proud to regard the people of the United States, however widely separated from ourselves, in a political, or in a geographical sense, they may be, at least as no unworthy scion of the Anglo-Saxon stock, and thus to be able to contemplate the race to which I belong, not only spreading itself more widely every succeeding year, but maintaining throughout that ascendancy, whether in point of energy of character, or of intelligence, in the New, which I trust it has established for itself in the Old World,—possessing indeed the glorious distinction, which those who have visited either French Canada, the Brazils, or Spanish America, will be equally ready to concede as their due—that of being the only member of the great European family of nations, which has not wofully degenerated by transplantation.

With such a nation, there must after all exist in the breast of every true Briton a greater congeniality of sentiment, and consequently a

more real sympathy, than with any of his continental neighbours; and it will be in all respects a subject for congratulation, if an increasing desire on our part to study the manners, the institutions, or even the natural history of your country, shall continue to create a gradually increasing intercourse between us, and thus lead to a better mutual understanding, and a more liberal construction of each other's peculiarities.

If therefore the present sketch of the Geology of this vast continent should kindle in the mind of any of my English readers a desire, to explore the regions which I have endeavoured to bring before their notice, I may plume myself at least on having contributed somewhat towards this great national object, and on having brought my countrymen into closer and more friendly connexion with the Society, and with the City, to which this Memoir is dedicated.

I beg to subscribe myself,

Gentlemen,

with great respect and esteem,

your obliged and devoted servant,

CHARLES DAUBENY,

Professor of Botany and Chemistry
in the University of Oxford.

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SKETCH

OF THE

GEOLOGY OF NORTH AMERICA.

BEING THE SUBSTANCE OF A MEMOIR READ BEFORE THE ASHMOLEAN SOCIETY, Nov. 26, 1838.

THE country, which I propose to bring before your notice on the present occasion, lies betwixt the 30th and 47th parallel of north latitude, and the 71st and 90th of west longitude, a distance as great from north to south, as from St. Petersburgh to Naples, and from east to west exceeding that from London to Warsaw.

The space comprehended within these limits does not therefore fall far short of 1000 miles square, and is equal to the greater part of Europe, for it will be found to exceed the dimensions of all the countries put together, which this portion of the globe contains, if Russia and Turkey be excepted.

For traversing so vast a tract I was able to allow myself barely a year, including the time occupied by the voyages to and fro, and even of this short period a considerable portion was consumed in the towns, during the winter season, when the observation of men and manners offered more attractions than the features of external nature.

It will therefore readily be perceived, not only that within the compass of one of these evening meetings it would be impossible to bring before you

more than a mere outline of so vast a subject, but that even supposing your time and mine to have admitted of further details, a sufficient excuse for confining myself to generalities would have existed in the cause already assigned—the shortness of my stay in the country itself.

If I had trusted indeed, in drawing up the present communication, to my own scanty notes alone, I should have found myself unable to impart to the facts laid before you, any thing like unity or connection; but I have largely profited, during my stay in the New World, by my intercourse with many intelligent naturalists, and have, I hope, in many instances, supplied the deficiencies of personal experience, by the aid of the information, so freely and so obligingly tendered me.

But the most abundant source from which I have drawn materials for this sketch, is the assemblage of reports relative to the geology of several portions of the Union, which have been published within the last few years, under the auspices either of the local or the general governments.

Amongst the geologists engaged in these undertakings, I may mention in the first place, our countryman, Mr. Featherstonehaugh[a], who is employed by congress in examining the territories, not as yet attached to any particular state, though the property of the confederacy collectively; and who, in obedience to their instructions, has described the district intervening between the Missouri and Red rivers, since incorporated in the new states of Arkansas and Missouri.

[a] Now, July 1839, appointed by the British government commissioner to survey the boundary line of the disputed territory.

Twelve states of the Union have already followed the example of the Federal government, in publishing geological reports; namely, Maine, Massachusetts, Connecticut, New York, New Jersey, Maryland, Pensylvania, Virginia, Michigan, Indiana, Delaware, Tenessee, and Ohio; whilst Michigan, Kentucky, and South Carolina have more recently, with the same intent, directed similar surveys to be set on foot in their respective territories.

One cannot but augur the best results to science, from an examination of the geological structure of so vast a tract, conducted on this systematic plan, especially when it is extended, as no doubt it will be, to all parts of British America.

It is possible, indeed, that the utilitarian views which appear in many cases to have prompted these undertakings, will not always be realized to their full extent; but we may be sure, that, like the farmer in Æsop, who, though he failed in discovering the treasure he was in quest of, got rich, nevertheless, by fertilizing his land, in the process of turning it up, the nation at large will reap the fruits of the labours it has promoted, in the impulse they will give to scientific inquiry, and the information they will tend to diffuse throughout the community.

Amongst the individuals, to whose oral instructions, as well as to whose published works, I feel myself particularly indebted [b], I may mention two brothers by the name of Rogers, one of whom,

[b] To the above list, I am now bound to add the name of my excellent friend professor Silliman, who, by kindly undertaking the trouble of revising this Memoir, has supplied the public with a sort of guarantee, that it is exempt at least from any serious errors.

professor Henry Rogers, has become personally known to many English geologists, during the residence he made in this country not many years ago. Since his return he has been appointed to the chair of geology in the university of Pensylvania, and in that capacity, after having completed a geological survey of New Jersey, is now engaged upon a similar one of the state in which he resides; his brother professor William Rogers, has an appointment in the neighbouring state of Virginia, being attached to the university founded by the exertions and influence of the late president Jefferson at Charlottesville, and to him we have to look for a geological survey of that state, in which he has been for several years engaged, and of which, indeed, the first fruits have already appeared.

It is fortunate, that the surveys of Pensylvania and Virginia, countries which, stretching across from the Atlantic to the Ohio, afford a key, as it were, to the structure of the entire continent, are confided to two individuals, so well qualified, from their general attainments, for the task, and so likely, by pursuing their labours in concert, to present a consistent view of the whole region which they describe. Hence I look forwards with confidence to the time when we shall be enabled, through the information thus afforded, to solve the important problem, how far there exists a resemblance between the mineral structure of the old and new continent, and whether an identification can be made out of the rocks found in these remote portions of the globe, to such an extent, as should justify us in applying to formations met with in one hemisphere, names that have been already imposed upon those of the other.

On this question the American geologists seem at present to be much divided.

Thus on the one hand, Mr. Conrad, who has undertaken the palæontological department of the survey of the state of New York, goes even so far as to identify certain of the formations contained in that state with the Ludlow rocks of Murchison, others with his Dudley limestone, a third series with the dye-earth of Shropshire, a fourth with the arenaceous sandstone of Wales, and a fifth with the Llandeilo flags[b].

On the other hand, the professors Rogers have acted upon the impression, that, although such an identification is not to be despaired of, yet it can in no instance be yet viewed as established, and hence, instead of attaching names to the rocks described by them, they have preferred for the present to designate them merely by a series of numbers, dependent on the observed order of their superposition.

There is one circumstance, however, which might lead us to suspect, that the similarity between this portion of the globe and our own is not so great as has been anticipated—I mean, the absence of modern volcanic operations, and even of all indications, over a considerable portion of the country under review, of any such having ever occurred; whence arises probably the more frequent horizontality of the strata, the greater simplicity of structure and continuity of the mountain chains, the more rare appearance of thermal and carbonated springs, and, when the wide extent of surface is taken into account, the unfrequent occurrence of earthquakes.

[b] See New York Report, for 1838.

In the above respects, the portion of North America, included within the range of the United States and of the Canadas, partakes more of the character of Russia and Poland, than of Germany, France, and Italy, of which latter countries, the analogues are to be met with in more southern latitudes of the western hemisphere, as in Mexico, Guatimala, and the West Indian archipelago.

This resemblance with the northern parts of Europe seems most complete, when we compare the latter with that portion of the American continent, which is included between the great lakes and the coast of Labrador, so far at least as that tract has been hitherto explored; for there, although primary or crystalline rocks prevail, there seems, nevertheless, to be an uniform dead level, rarely relieved by any abrupt elevations, whereas, south and east of the lakes, this uniformity is broken in upon by the chain of the Alleghany mountains, which stretch in one continuous line from north-east to south-west.

I will consider, then, in the first place, the indications which this continent affords of the action of water, and afterwards proceed to the changes that appear to have been wrought in it by the operation of fire.

There is probably no portion of the globe, where the effects of the daily and continuous action of running water may be better studied than in the great valley of the Mississippi, through which, that mighty river, with its numerous tributaries, is constantly carrying down such masses of mud and drift timber, as will, in the course of years, convert a large portion of the Gulf of Mexico into a continuation of

that vast alluvial tract which it has already formed, and may, perhaps, if time enough be allowed it, connect at last the island of Cuba with the continent of North America.

These processes, however, have been so fully discussed by Mr. Lyell, that I shall abstain from any further mention of them, except to remark, that amongst the cases of drift timber, which he enumerates as collected in the beds of these rivers, he has omitted the most remarkable one, I mean the *raft*, which for seventy miles in extent had blocked up the course of the Red river [c], until the last

[c] The following is the description given by Mr. Flint of this obstruction to the navigation of the Red river, (vol. i. p. 539.) "Through the greater amount of its course the Red river winds through immense prairies of a red soil covered with grass, and vines that bear delicious grapes. On its banks is the favourite range of the buffalo, and the other game peculiar to the immense western ocean of prairies. About thirty leagues above Natchitoches commences the raft, which is nothing more than an immense swampy expansion of the alluvia of the river, to the width of 20 or 30 miles. The river spreading here into a vast number of channels, frequently shallow of course, has been for ages clogging with a compact mass of timber, and fallen trees wafted from the upper regions. Between these masses the river has a channel, sometimes lost in a lake, and found by following the outlet of that lake back to the parent channel. There is no stage of the water, in which a keel boat, with an experienced pilot, may not make its way through the raft.

"The river is blocked up by this immense mass of timber for a length in its meanders of between 60 and 70 miles. There are places, where the water can be seen in motion under the logs. In other places, the whole width of the river may be crossed on horseback, and boats only make their way, in passing these places, by following the inlet of a lake, and coasting it to its outlet, and thus finding the channel again. Weeds, flowers, shrubs, and small willows have taken root upon the surface of this timber, and flourish above the waters. But in all these places the courses of

year, when it was so far removed by the exertions and skill of captain Shrive with his snag boat, as to render the navigation practicable, and thus to extend the water communications of that portion of the United States nearly 1000 miles further westward than before, in the direction of the Rocky mountains and the frontiers of Mexico.

Of the more violent action of water we observe the effects, in the loose erratic blocks so extensively distributed over the surface of both the Canadas, of the State of New York, and of various parts of New England.

Those of the Canadas are noticed by my friend Major Bonnycastle, in the first volume of the Transactions of the Literary and Historical Society of Quebec, page 62.

The boulders of the Jura and of Germany, he remarks, are of small import and of limited extent, when compared to those of Canada. I have travelled by land or along the shores from Prescott to Lake Erie, and everywhere these singular strangers present themselves to view, thickly spread over rocks and soils, to which they might, in a few in-

the river, its outline, and its bends, are distinctly marked by a margin of forest trees, which grow here on the banks, in the same manner as they do where the channel is open.

" It is an impediment of incalculable injury to the navigation of this noble river, and the immense extent of fine country above it. There is probably no part of the United States where the unoccupied lands have higher claims, from soil, climate, intermixture of prairies, and timbered lands, and every inducement to population, than the country between the raft and Kiamesia.

" The river above the raft becomes broad, deep, and navigable for steam boats, in moderate stages of the water, 1000 miles towards the mountains."

stances, be supposed to have originally belonged. I have observed them equally strewing the shores of the Lakes and of the St. Lawrence, and covering the mountains and the hills, and that too, as in Pelham township, at a very considerable elevation. Here (at Kingston) they line the low limestone shores of the Lake, and consist of hard schists, of granites, of gneiss, of quartz, of black basaltic looking masses, and of nearly pure felspar.

The granites on the higher plateaus of the limestone of Fontenac are so numerous and varied, that I am confident in a few hours above a hundred specimens of different kinds might be procured, but there are no data, either from their form or their position, on which a theory of a plausible nature as to the route they have travelled could be drawn. The diluvian dressings, as they are rather affectedly termed, have been so variously rolled about, that the side on which these boulders have received the most severe chastisement is undoubtedly not recognizable. I have fancied, that I could perceive there was a kind of regularity in their general position, but I cannot as yet speak with certainty. I conjecture that they are in nearly parallel lines on the flat tables which this part of the country affords, but I shall not hazard a statement until I have opportunity to inquire more largely. Altogether the subject of the Canadian boulders appears one of the deepest interest.

Those of the State of New York in Long Island and the adjacent parts, are described in the Geological Survey for 1837 (p. 87, 88), and for 1838, p. 133.

They vary from the size of a pebble to masses weighing several hundred tons, are found inter-

stratified with deposits of sand, clay, and gravel, and when first disinterred exhibit scratches on one or both of their sides. These characters, however, correspond with that of the rocks in their immediate vicinity, and are always in a southerly line from their beds, so as to indicate the direction of the force by which they were detached. Mr. Mather considers the theory of transport by ice, as corresponding more closely with the facts, than any other that has been proposed. The occurrence of these boulders and blocks, as it were in nests on the south side of the hills, and generally on elevated grounds, he conceives strongly favours this view of the subject.

The erratic blocks found in New England are particularly dwelt upon by professor Hitchcock, in his Report on the Geology of the State of Massachusetts, p. 152.

The whole country, he says, east of a line drawn from Providence to Boston, except the summits of a few of the highest mountains, and some alluvial valleys, is covered with diluvial blocks and gravel.

But from Boston to the extremity of Cape Ann, embracing a considerable proportion of Essex county, the amount of boulders is prodigious, and some of them are not less than thirty or forty feet in diameter; and yet so powerful was the diluvial current, that these must have been removed from their original position, and many of them now occupy the summits of the highest hills in that region.

Professor Hitchcock also alludes to other phenomena indicative of the same event, which are presented in the country now under review.

One of these is the gorge, between mount Tom

and mount Holyoke, in the valley of the Connecticut near Northampton, Massachusetts, through which the river now finds its way—a gorge, which could not have been cut by the action of the stream, since the latter would have flowed through that part of the valley which lies west of the Greenstone ridge now severed asunder, following the course taken by the Farmington Canal, where no such impediment would have been presented. For it appears by the surveys taken of that canal, that in no place is the valley more than 134 feet above the present level of the river at Northampton, whereas the ridge through which it passes is from 800 to 1000 feet high.

Another circumstance which seems to point towards the same conclusion, is the existence of grooves and scratches upon the surfaces of the rocks, even on the summits of the highest hills.

At the top of mount Holyoke, at an elevation of 900 feet above the sea, I saw these distinctly marked upon the face of the greenstone or trap rock, which caps the hill.

These markings were from north to south, and thus coincided in direction with certain slight valleys seen near the same spot at an equal elevation, the direction of which is not conformable with the bend of the mountain itself, being from north to south.

Hitchcock adduces numerous examples of the same phenomena in his Report on the state of Massachusetts, and has likewise alluded to the same in a Memoir on the Geology of Portland in the State of Maine.

" Whoever," says he, " is in doubt, whether there are any marks of diluvial action in the vicinity of that city, let him stand upon one of these elevated

spots, and account, if he can, for that accumulation of rolled masses under his feet in any other way than by a strong current from the north." After speaking of the diluvial grooves and scratches on the rocks around and within Portland, which he thinks cannot be confounded with those resulting from the unequal hardness of the successive layers of slate, he goes on to say, that Dr. C. T. Jackson of Boston, and Mr. Frederic Alger, in their Memoir on the Geology of Nova Scotia, have rendered a similar testimony with respect to the diluvial phenomena of that country. "Thus," says professor Hitchcock, "we have an almost unbroken series of observations on this subject, from the extremity of Nova Scotia to the western side of our great lakes, a distance of from 1200 to 1500 miles—and with a few local exceptions perhaps, there is decisive evidence of a comparatively recent and powerful rush of waters from the north and northwest."

Thus far professor Hitchcock, who, in common with the majority of American geologists, adopts the language and the theoretical views of professor Buckland; but I perceive from a late number of Silliman's Journal, that attempts have been made to interpret such phenomena in accordance with the principles advocated by Mr. Lyell.

Mr. Hayes of Buffalo, in a Memoir on the Geology of Western New York State, endeavours to shew, that the mere action of the waves and tides upon the rocks, after they became elevated above the surface of the ocean, would bring about all the effects hitherto attributed to the operation of running water. And it may be granted, that the mechanical aggregates so universally distributed amongst formations

of every age may be thus accounted for; but I do not see, how the transportation of boulders to so great a distance from their parent rock can admit of this simple mode of explanation. In adopting it, the author seems to have overlooked the fact, that the force of submarine currents extends but a little way beneath the surface of the ocean, and that even the gulf stream could have no power to move a block of stone along the bed of the sea underneath it, so soon as it was once safely deposited at its bottom.

Accordingly, the geologists in our own country, who reject the notion of diluvial currents, seem in general disposed to call in the aid of other machinery for the transportation of such masses, and Mr. Lyell believes, that their distribution may be accounted for, by supposing them to have been carried by ice, at a time when the lands over which they lie scattered were submerged beneath the sea.

It is probable, that each person will incline in favour of one or other of these hypotheses, according to the degree to which he is disposed to carry his assent to the general principles of Mr. Lyell's theory.

Those who believe, that all the other revolutions of the earth's crust, which geology has revealed to us, may have been brought about in a slow and gradual manner, will of course feel reluctant to resort to a violent and transient cause for the purpose of explaining this one solitary phenomenon; but others, who, though yielding assent to the doctrine, that the laws of nature have ever continued unchanged, conceive nevertheless, that sudden and violent, as well as gentle and gradual operations, make a part of her present system, will probably regard the transport of erratic blocks, as a consequence of one or more of those mighty inundations,

which would have been caused by the sudden elevation of an extensive tract, or by any change in the distribution of land and sea, which should have been brought about within a short period of time.

The term, *diluvial action*, applied to this supposed series of operations, though it may at one time have assisted in giving currency to these views in the world at large, seems of late to have excited a prejudice against them amongst geologists; it has led to an impression, that the theory alluded to must either be reconciled in all respects to the conditions of the Noachian deluge, or must be abandoned altogether; whereas it is quite possible, on the one hand to admit, on the authority of the sacred records, confirmed by the traditions of pagan nations, the reality of the event in question, without attributing to it the phenomena above alluded to; and on the other hand, to maintain, on grounds purely geological, that large masses of water have from time to time swept over our continents, without supposing them to have acted simultaneously upon the entire surface of the globe, or pretending to identify any one of them with the deluge recorded by Moses.

With respect to the changes brought about on the surface of the American continent by other agencies than those of water, changes more generally referred to the elevatory movements caused by subterranean heat, I may mention as the most prominent event of that character that has occurred within the limits of the continent under our present consideration, the uplifting of the Alleghany mountains, with which chain are associated the few thermal springs this country affords, the relation of which to the rocks themselves will however be

better understood, after I have stated some particulars regarding the distribution of the mountains throughout the continent in general.

It appears then, that a range of unstratified primary rocks extends from the State of Alabama through North Carolina and Virginia, constituting what is there called the Blue Ridge, which itself forms the eastern boundary of the mountain tract, comprehended by geographers under the general denomination of the Alleghany Chain.

But the primary rocks are by no means confined to the high country which constitutes the Blue Ridge—they extend eastward nearly to the shores of the Atlantic, and are only concealed, as we approach the eastern coast, by the tertiary or alluvial deposits there superimposed.

In the tract occupied by these unstratified rocks, between the Blue Ridge and the low alluvial district bordering on the Atlantic, is the gold region of the United States. The ore, which is represented as being abundant, especially in the states of N. Carolina, Georgia, and Virginia, exists in veins of quartz, penetrating talcose and chloritic slates, accompanied with iron pyrites. These veins are not regarded by professor Rogers as cotemporaneous, but as resulting from igneous injection, being very irregular in their direction and forms, contracting and expanding suddenly, and producing various changes on the contiguous rocks. Professor Silliman, however, regards the gold ore in Virginia[e] and probably in North Carolina, as occurring in beds or layers cotemporaneous with the including rock, and running in the same direction.

[e] Professor Silliman's personal examination of the gold region was confined to Virginia.

Near Richmond in Virginia, a bituminous coal formation is found in a bason existing in the gneiss. The coal occurs in considerable quantities, and is worked extensively.

From the statement already given with regard to the range of the unstratified rocks east of the Blue Ridge, we shall not be surprised to meet with gneiss at Philadelphia and near New York, nor at finding, that as the continent extends itself more to the east, in the states of Connecticut and Massachusetts, a greater extension is given to the same class of formations, which, excepting in a few valleys, where the fundamental rock has been denuded to a depth sufficient to admit of the deposition of other strata within its hollows, seems for the most part to predominate.

In New Jersey, the primary ridge traverses the Delaware river at Trenton, and extends from thence to Staten Island, near New York, forming in the above-mentioned State, either a wide zone of many nearly parallel ridges, with steep sides, and a very undulating outline, or else low mountain ranges of moderate elevation, which rarely exceed 600 feet. Granite occurs at Staten Island, and is accompanied with a range of serpentine rocks which extends from New Brighton to a little west of Richmond, a distance of eight miles, and from thence is prolonged to Hoboken opposite New York, where it forms the repository of various interesting minerals, such as nemalite, native hydrat and carbonat of magnesia, marmolite, &c.

The western boundary of this primary chain in the state of New York runs nearly parallel with the general course of the Hudson river, which it crosses between Peekskill and Newburgh, and the beautiful

mountain scenery, which we enjoy during the voyage by steam from New York to Albany, is in great measure caused by the abrupt and lofty escarpments produced and displayed by this magnificent stream, during its tortuous course through the midst of these ancient rocks, from the Highlands about West-point to the Cattskill mountains.

In the southern states the primary chain appears to be covered on its eastern side by no rocks more ancient than the tertiary, but in New York State, and in the portions of New England which it traverses, others belonging to the transition or the Silurian system rest upon its flanks.

Thus we find a range of hills consisting of blue limestone with organic remains, designated by prof. Dewey as transition, extending from a few miles east of lake Champlain, by Bennington in Vermont, to New Lebanon and the Cattskill mountains in the state of New York; and on the eastern boundary of the primary chain near Boston, a sandstone and conglomerate rock, which Hitchcock has denominated greywacke, intervenes between it and the sea. This rock is the repository of the anthracite coal, of Rhode Island, and of Mansfield in Massachusetts, though there is stated to be this difference between the mode of its deposition and that of the more modern coal formations, that it does not, in the latter named locality at least, lie in a bason dipping in all directions towards a common centre, but alternates with the greywacke, being inclined in the same uniform direction as the beds of the latter rock are found to be.

Of a much later date than the above is the sandstone rock, which may be traced along the bed of

the Connecticut river from Middletown near its embouchure in Long Island Sound, where primary slates appear, as high as Greenfield and Miller's Falls near the southern boundary of Vermont, north of which line this stream again passes among primary rocks, of the same description as before.

Thus the sandstone alluded to appears to form the substratum throughout the whole of the delightful valley of Connecticut, not more celebrated for the pleasing features of its scenery, than for the general comfort, thriftiness, and respectability of its rural population. In its general style of cultivation, in the absence of those extensive forests so common elsewhere in the United States, and in the appearance which the trees present, from being dotted about in groups and patches, instead of collected into large masses, the valley reminded me of some of the better parts of England; whilst the profusion of glistening white paint bestowed on the exterior of their wooden dwellings, and in general the studious neatness and almost quaker-like primness displayed in their domestic arrangements, more resembled what we may see in Holland.

But in what other part of the world shall we have occasion to witness, not merely that entire absence of squalid poverty, but in such perfection that "*aurea mediocritas*," which it needs no republican predilections to contemplate with satisfaction [f]!

It is indeed a condition of society, which no system of government could create, but which is the

[f] The writings of Miss Sedgwick, whose graphic delineations of domestic manners sometimes remind us of our own Miss Edgeworth, may be referred to, as affording a pleasing picture of the state of society in this favoured portion of the Union.

happy and spontaneous result of a combination of circumstances rarely found to concur—the union of frugal and moral habits, with an universal diffusion of education—few opportunities of amassing wealth, and yet sufficient inducements existing for steady industry—a spirit of independence, manifesting itself indeed too often in a repulsive coldness of manner, but not unaccompanied with a due respect for public opinion—all these elements of prosperity secured to the inhabitants for a long period of time, by the ready outlet afforded to any redundant population; and, what is of more importance still, by the tendency in the body politic to throw off instantly its *peccant humours*, owing to the temptations held out for its more turbulent and restless members to emigrate into other lands.

These are amongst the circumstances, which render the condition of the inhabitants of this favoured valley so enviable, and which place them at an equal distance from the exuberant wealth and lavish display of a commercial metropolis, as they are from the rudeness and the destitution, which are the inevitable concomitants of every newly formed community.

Professor Hitchcock regards the greater part, if not the whole, of the rock which forms the substratum in this valley, as equivalent to our new red sandstone, though, if this be the case, it is remarkable, that whilst salt is so abundant in the older sandstone and other deep seated rocks of North America, it does not occur in this, which we regard in Europe its most appropriate position. [g]

g Professor Silliman informs me that in the Rocky mountains salt is found regularly stratified with the red marl and sandstones, probably the equivalent of the English and Polish formations. "I had the fact" (he says) "from a very intelligent missionary who

A vertebrated animal, probably a saurian, ichthyolites belonging to the genus palæothrissum, and vegetable impressions, are met with in it, and some of its beds are said to resemble those of the copper slate of Thuringia: its dip is to the east, its beds being deposited in a hollow existing in the mica slate, gneiss, and granite. It appears to have been deposited since the primary rocks obtained their present position, having undergone no elevatory movement itself, but having been deposited tranquilly in the midst of these older formations, the irregularities existing in it being the effect of subsequent denudation.

The discovery made by professor Hitchcock of birds' tracks on the surface of this sandstone is very remarkable, as it traces back the existence of this class of animals to a period long antecedent to that, at which the earliest vestige of their bones has as yet been discovered.

As these have been both described and figured in professor Buckland's well-known Bridgewater Treatise, I will only remark, that having myself visited one of the spots where these tracks have been recognised—a shelving ridge of rock in the bed of the Connecticut river—and compared the impressions seen on the surface of the stone with the more perfect ones selected by the professor for his own museum at Amherst, I went away, fully impressed with the belief, that they could have been produced in no other way, than by the treading of birds of various sizes upon a soft and plastic material.

saw the salt in places and for a great extent; his name is Parker (rev. Samuel, A. M. of Ithaca, New York). He has published a very good account of his travels."

Many of them indeed were obscure, and no one specimen perhaps sufficiently distinct, to establish by itself the fact in question—a comparison of them one with another, a measurement of the distances between them, and an examination of many other little circumstances, which appeared to dovetail one into the other, were required for full conviction.

The tracks were of various sizes, the largest being not less than sixteen inches from one extremity to the other, being broader as well as longer than the footsteps of the ostrich, our largest living bird.

There was generally a spur behind the heel, extending out a considerable distance. In one instance there were markings, resembling the corrugations of the skin connecting the talons, and seeming to prove that the animal was web-footed.

In some cases the impression made in the sandstone was oblique, as if the animal had slid in treading on soft mud.

There were likewise other impressions of footsteps, that represented four toes directed forwards, instead of three, as was the case commonly, so as to lead to a doubt as to the kind of animal by which they were occasioned. Sometimes the steps were twisted alternately to the right and left, and in a few cases we could make out several acute talons appended to the extremities of the toes.

It is curious, as prof. Hitchcock observes, that many of the surfaces upon which these impressions appear are highly inclined, an additional proof, that the sandstone strata had been shifted from their original position, since they first became consolidated.

But the circumstance, perhaps, which most deserves to be insisted on, as establishing a distinction, between the rocks situated in the midst or on the eastern flank of the primary range, and the series hereafter to be described which lies to the west of that chain, is the existence of dykes, or intrusive masses of trap, in all portions more or less of New England.

These are particularly abundant in the valley of the Connecticut, testifying to the fact, that subsequently to the elevation of the Alleghany chain and of the Silurian system of rocks, as well as during the period of the deposition of the latter, igneous operations in this portion of the present continent have been frequent.

Professor Silliman pointed out to me several of these dykes intruding themselves through the sandstone near Newhaven, and professor Hitchcock has traced the greenstone from this place to Northampton in a line, which, though frequently interrupted by gorges and defiles produced by subsequent denudation, seems nevertheless to have been at one time continuous. Here, in the immediate vicinity of the spot at which the bird-tracks already described are to be seen, the greenstone assumes a considerable development, putting on the appearance of stratification, and being interposed between the sandstone, in wedge-shaped masses inclined at an angle of 50°. or even 60°. Thus at Mount Holyoke it seems to lie betwixt two beds of sandstone, the upper of which is seen at the level of the river, a little above which the greenstone crops out from beneath it, and thus continues to the summit of the mountain. At the back of the hill, however, another bed of

sandstone appears, rising from under the trap, so that the greenstone seems to be interposed between the two.

The latter exhibits a distinctly columnar arrangement on the face of the hill, and, owing to the disintegration it has undergone, the upper rows of pillars stand out beyond the lower ones, in such a manner, as to form a tessellated roof over the head of the observer, as he skirts the side of the cliff.

On the edge of the river below Mount Holyoke, a second bed of greenstone occurs, still more distinctly columnar, and this, projecting into the stream by which it is covered when the water is high, exhibits a miniature representation of the Giant's Causeway, which the professor proposes calling "Titan's Pier."

Thus there appears at this spot to be an alternation of two beds of greenstone with the same number of beds of sandstone, but it is probable that the appearance is illusory, and that the trap has in reality been protruded through the sandstone, as dykes manifestly are. Amongst the primary and "transition" rocks round about Boston, greenstone occurs in both these forms; it here alternates with greywacke, passes into syenite, and traverses these and other rocks as distinct dykes. The latter are well displayed near Cambridge, and on the coast about Nahant in the vicinity of Boston.

It appears from Dr. Charles T. Jackson's account of the geology of Maine, that trap dykes are even more abundant along the coast, intersecting the primary rocks, the limestone, and sandstone, in all directions.

But it is in Nova Scotia, along the coast of the

Bay of Fundy, that the trap formation appears to attain its greatest development.

For the particulars I must refer to Jackson's and Alger's interesting work on the geology of that country, merely observing, that it is here associated with a sandstone, rich in salt and gypsum, and incumbent upon coal.

As this is probably the most northern point in the new continent in which this latter substance has been found in any quantity, it is interesting to remark, that the vegetable impressions it contains are of a tropical character.

In order to complete this brief sketch of the rocks that lie to the eastward of the Blue Ridge, I ought to mention those described by professor H. Rogers in his Report on the Geological Survey of New Jersey.

Omitting for the present all notice of those on the north-west of the Blue Ridge, I shall merely allude to a series of rocks which rests unconformably on the south-eastern flank of these mountains, dipping to the north-east, and therefore appearing to be deposited at some period subsequent to the elevation of the chain. The rock which comes most closely into contact with the primary, is a coarse breccia, which seems to extend to the Potomac river in Maryland, where it has been quarried for ornamental purposes, under the name of the Potomac marble, being the material, of which the columns of the house of representatives at Washington has been constructed. Above this is a succession of shales and sandstones, consisting for the most part of pebbles, and grains of the same materials, as those composing the primary strata upon which they may be presumed to rest.

These strata are intersected by dykes of trap, which produce remarkable changes in them, giving rise to crystals of epidote, tourmaline, and other minerals, hardly ever found, except either in primary or volcanic formations.

The trap seems to have overspread the sandstone, forming a continuous bed resting upon it.

The nature of the minerals themselves appears to be determined by the chemical composition of the imbedding rock; thus epidote and idocrase are connected with the shales which contain a small portion of limestone, whilst tourmaline occurs in a material which evidently once was sandstone.

All the circumstances I have mentioned tend to the conclusion, that this sandstone formation is of the same age as, if it be not an actual continuation of, that already described as occupying the valley of the Connecticut.

Intervening between this rock and the sea, occur certain arenaceous beds, with fossils answering to those of the green-sand of England, and others corresponding in date with the Pliocene rocks of Lyell.

These, however, I pass over, as they have been lately fully brought before the scientific public, in a work so easily accessible as the proceedings of the British Association, by professor H. Rogers' Report on the Geology of America, published in the fifth volume of the Transactions.

We have now traced the primary range through the State of Massachusetts, and must next follow it into New Hampshire, where it constitutes the White Mountains, which have hitherto been considered the loftiest group within the compass of the

United States, exceeding by 2000 feet at least the greatest elevation which the Alleghany mountains were known to have attained.

If, however, we can rely upon the report of professor Mitchell of Chapel Hill University, which will be seen in a late number of Silliman's Journal, it would appear, that the Alleghanies reach in North Carolina a height greater even than that of the White mountains, and far exceeding that of the Peaks of Otter in Virginia, which were before considered the most elevated spot in that range.

Thus, whilst the Peaks of Otter are only 3,955 feet above the level of the sea, and even mount Washington, the highest peak of the White mountains, does not exceed 6,234, it is stated that the Black mountain in North Carolina is no less than 6,476 feet, and the Roan mountain in the same state, the next in point of altitude, 6,038 [h].

The White mountains, which constitute the culminating point of the Alleghanies on their northern extremity, present in general a series of circular wavy detached masses with rounded flat summits. They consist chiefly of gneiss, granite being found only in a few places. Professor Hubbard of Dartmouth College, New Hampshire, has described the occurrence of trap dykes intersecting the above-mentioned rocks [i].

The same chain continues into Canada, but is there found at a much lower level. Near Quebec it forms a range of hills above 1000 feet in height, and is afterwards seen in the northwest bank of the St. Lawrence to an extent hitherto unexplored.

[h] See Am. Jour. vol. xxxiii. p. 322, and vol. xxxv. p. 377.

[i] See Am. Jour. vol. xxxiv. p. 108.

Such then is the direction of the primary ridge on the eastern side of Lake Champlain, but another portion of the same, divided from the former by the valley in which these lakes occur, is found to rise to the west nearly to as great a height; for in Essex County, State of New York, the highest peak has been estimated, by barometrical measurement, at 5,400 feet.

It affords a remarkable proof of the imperfect knowledge we possess of this vast continent, notwithstanding all that has yet been done to advance it, when we find that in the State of New York, one of the most populous perhaps, and the longest settled in the union, Massachusetts and Connecticut excepted, one district, in which such lofty mountains are situated, should have remained unexplored till the year 1837, when a body of naturalists from New York first made known to their countrymen their situation and height.

This exploring party was compelled, from the nature of the country, to proceed in the same manner, and with the same precautions, as they would have done in the wilds of the extreme west, carrying with them their store of provisions, bivouacking at night in the woods, and varying their scientific occupations by encounters with wolves and panthers[j].

The rocks of this district differ from those seen in the Alleghany chain to the south, but agree with others which appear to abound in high latitudes in Canada.

They seem to consist principally of Labrador felspar and Hypersthene rock, like the Cuchullin

j See in Am. Jour. vol. xxxiii. a Memoir by Mr. Redfield.

hills in the Isle of Skye, and like them are occasionally intersected by large dykes of trap. A blue limestone stratum is said to overlie the primary or crystalline rocks above mentioned, and this has undergone a very remarkable conversion, near the line of contact, into a white marble spangled over with minute specks of anthracite, just the same that has happened to the limestone of New Jersey, as will be particularly noticed, when we come to speak of the rocks resting upon those of the Blue Ridge, on their western flank.

Betwixt the two groups of mountains above described are situated lakes George and Champlain, and a continuation of the same valley farther to the south receives the river Hudson, from Albany to New York.

From Essex county, the mountains above described stretch westward to Kingston in Upper Canada, where they join, and become blended with, another low chain, which stretches across the continent from south-east to north-west.

This chain has been traced by Dr. Bigsby, from the Thousand Islands, at the outlet of Lake Ontario, along the northern shores of lakes Simcoe, Huron, and Ontario. It probably extends uninterruptedly to the Rocky Mountains, although from the notes transmitted to the geological society, by the late lord Selkirk, it would appear, that primary rocks were lost sight of about Lake Winipeg, and that the prevailing formation was there calcareous.

The limestone seen resting on the flanks of the primary chain, on the borders of Lakes Huron and Superior, appears to belong to the same period as that of Trenton and Quebec, containing Orthocera-

tites, Trilobites, Cyathophylla, and numerous other Corallines, some of which are new.

The Rocky, or Chippeway Mountains, as they are more appropriately termed, extend from north-west to south-east, in a line nearly parallel with the coast of the Pacific, from which they are in general from 500 to 600 miles distant.

They stretch from the Isthmus of Panama, nearly to the Arctic ocean, being found by captain Franklin far north of the Mackenzie river. Thus they form the boundary which separates California and the Oregon territory, from the vast prairies which lie to the west of the states of Arkansas and Missouri.

The base of these mountains is calculated at 300 miles in breadth, and their loftiest summits, which are covered with perpetual snow, are generally said to reach the height of 12,000 feet, but professor Renwick of New York, calculates them at nearly double this height. At the few points at which they were examined by the earliest explorers of the country, they were found to consist of primary rocks, granite, gneiss, quartz-rock, &c. and on their eastern flank an extensive formation of red sandstone was remarked.

But more recent travellers have noticed, in various parts of the chain, volcanic rocks very generally distributed, and although the reports of unscientific persons may not be precise enough to convince us, that the rocks they describe belong to the class of subaereal lavas, yet we may gather from their accounts sufficient indications of the fact, that volcanic operations have continued to a very late epoch, and even yet are not wholly extinct.

This appears to be particularly the case in the

west of these mountains, where the same line of igneous operations is continued, which exists more to the south in California.

Hot springs have been discovered in several parts of the chain, and it seems probable, that some of the salt lakes met with amongst the mountains may prove to have been the craters of extinct volcanos.

In a wide sense then, it might be said, that the central portion of the North American continent is surrounded, on the north, east, and west, by a chain of primary formations, and that the entire space included betwixt the Alleghany and the Rocky Mountains constitutes the great valley of the Mississippi.

But in giving it this name, we must not be led to imagine, that the whole intermediate tract is filled up with alluvial or with tertiary deposits, or to suppose, that it maintains throughout an uniformly low level.

Such a description, indeed, applies to the district included within an area of about a hundred miles to the westward of the Mississippi river, so far at least as the point where the junction takes place between it and the Ohio, and it might also serve to designate an equal extent of country to the east of this great vein of the American continent; but the low alluvial tract here alluded to, which is probably composed entirely of the deposits from the river, and which once constituted an arm of the sea, communicating with the Gulf of Mexico, is bounded by the western portion of the Alleghanies to the east, and by a ridge, consisting of clay-slate, quartz-rock, and sandstones of various degrees of consistency, which I myself followed from the hot-springs on

the river Washita, in the state of Arkansas, to St. Louis, in the state of Missouri, a distance of nearly 400 miles.

The only rocks, that seem to break the uniformity of character belonging to this range, are certain porphyries near the mining district of Missouri, with which are associated large protruding masses of specular iron ore.

These have been noticed by Mr. Featherstonehaugh in his Geological Report, and appear to constitute one of the largest accumulations of ferruginous matter in the world.

They enter largely into the bulk of an elevation called the Pilot Knob, standing up about 500 feet above the level of the neighbouring country; and entirely compose another called the Iron Mountain, about 300 feet in height, and two miles in circumference [k].

At the base of this latter hill a company from the eastern states have projected a new city, which makes an important figure on paper, and is represented in the Plan as having already started into existence; as being connected by two railroads with the Mississippi, and by another with Santa Fè in Mexico; as the seat at once of learning and of manufactures; and as containing already within

[k] Prof. Shepard, Lecturer on Natural History at Yale College, Connecticut, and on Chemistry at Charleston, S. Carolina, has also given an account of these rocks from personal examination.

He informs me, that a region of red granite, frequently intersected by trap dykes, prevails for a breadth of at least six miles, between the compact felspar and porphyritic range; (which bears the specular iron deposits;) on its eastern border separating the iron region from the metalliferous transition limestone.

itself churches, parks, colleges, and all the accompaniments of civilisation[1].

[1] I insert the Prospectus, as a curious specimen of effrontery on the part of the projectors of this scheme, such as (without hazarding an opinion as to its feasibility) I may venture to say would only have been attempted amongst a people possessed by a rage for speculation, to the degree which belongs to the American character.

"PROSPECTUS.—Missouri City is situated on a beautiful plain, at the base of the celebrated Iron Mountain, 90 miles south of St. Louis, and 40 west of the Mississippi river. It is the central point of all the chartered and contemplated railroads in South Missouri. Climate remarkably bland, as healthy as any part of the Eastern States. Winters mild. Scenery mountainous, and beautiful as that of the North river. Springs of the best water, abundant, and clear as crystal. Pine lumber abundant, at one cent a foot. Brick, limestone, marbles, and granite building stones, abundant, of the best quality, and near by. Farming lands in the vicinity equal to the best in the west. Rich mines of *lead, zinc, copper, tin, &c.*, also two Iron Mountains in the neighbourhood. The Missouri Iron Company, with a chartered capital of 5,000,000 dollars, will make this place the seat of a part of their iron works. The Missouri City University, with an endowment of 75,000 dollars a year for 45 years, will be located as represented in the City plot. *Education in this University gratuitous to the citizens.* The proprietors have given to the University 1000 acres of land near the City for a manual labour and experimental farm; also to the City, grounds for 62 public parks, 8 churches, 2 markets, 6 asylums, 1 City hall, 1 City lyceum, 2 hotels, all the University buildings, 1 young ladies' institute, 4 public schools, a City burying ground, and a City flower garden. No dram shop, lottery, gambling office, or house of ill fame, ever to be allowed in the City or on the lands within three miles. No slaughter, butcher shop or yard, or tan yard; no glue, starch, candle, soap, turpentine, powder, or oil manufactory, or any other kind of manufactory tending to infect the air, or annoy the neighbourhood, to be allowed in the City limits.

"Communications, post-paid, directed to Missouri City, St. Francis Co., Mo.

"J. L. VAN DOREN,
"HENRY PEASE, } Proprietors."

Having, whilst in Philadelphia, seen and perused the Prospectus, I made a point of visiting the spot, in expectation of finding there something resembling a town; but, to my surprise, could discover but one solitary house occupied by a person from New York, who had been induced to take up his abode in the wilderness for the purpose of making bricks for this nascent metropolis.

All the surrounding tract of country for many miles, including the Iron Mountain itself, "*this central point of all the chartered and contemplated railroads in South Missouri*," was, with the exception of a small farm about the premises alluded to, in as untamed a condition, as it could have been when the red Indian roamed freely through its recesses; and still furnished, if I may judge by my own experience, an unmolested retreat to the rattlesnake.

Near the Warm Springs on the Washita River, in the state of Arkansas, I observed a considerable mass of the same ore of iron, constituting what is termed the Magnet Cove. The term *cove*, in the American sense, implies, not necessarily the presence of water, but simply a circular hollow, and the rocks immediately surrounding this, consist, according to Featherstonehaugh, of greenstone, whilst the soil covering the hollow itself is scattered over with detached blocks of magnetic iron ore, the relation of which to the trap formation does not seem as yet to be made out.

We perceive then, that the valley of the Mississippi, in the more limited sense in which I now employ the term, is inclosed by a range of primary

rocks, on the north, east, and west; but that on the south all traces of this class of formations are lost, the only ones that appear at the surface being greensand and tertiary strata, as we observe in Tennessee, and in the more southern portions of Arkansas[a].

The highest portions of the Alleghany ridge, properly so called, of which we have any geological information, (for the White Mountains are not commonly regarded as constituting a part of that chain, and the rocks of North Carolina have not as yet been described,) appear to lie in Virginia and in Pensylvania; and here too, as might be expected, the rocks superimposed are found to be most tossed about, and most highly inclined, whereas in other parts, as in Canada, the primary rocks are less elevated, and the newer formations superimposed more horizontal. Thus near Quebec we seem to have evidence, that no elevation of the strata has taken place since the deposition of the dark-coloured fossiliferous limestone of that country, which is probably of higher antiquity than the carboniferous limestone of this country.

This appears from the fact, that at the celebrated Falls of Montmorenci, where we have a section of this rock, it is seen to rest unconformably, in horizontal strata, upon highly inclined beds of clay-slate, which are incumbent upon syenite.

[a] My friend Mr. Lea of Philadelphia, who is well known as an accurate conchologist, and an extensive collector in this and other departments of natural history, has described and figured in a very beautiful and correct manner a series of shells obtained from Claiborne in Alabama, which he regards as belonging to the London clay and calcaire grossier. They are found about 200 feet above the level of the Alabama river, which runs into the gulf of Mexico, and 90 miles from its mouth.

Just above the Falls, the limestone forms a series of irregular natural steps, in a ravine worn by the river in its descent to the St. Lawrence.

The greater part of Canada appears remarkably distinguished for the level character of the country.

No elevated range of mountains is known to exist between the lakes and the distant coast of Labrador, although the level of the country is generally found to rise as we proceed north, up to a certain latitude, and although the rocks are composed of granite, syenite, and still farther north, of hypersthene rock and saussurite.

The absence of any lofty chain of mountains stretching from east to west, like the Alps, the Pyrenees, and several other associated chains in Europe, ought doubtless to be included amongst the causes already enumerated by Humboldt, as accounting for the extreme cold which pervades the whole of this continent to a very low parallel during winter[b].

The chill blasts proceeding from the North Pole have thus no material barrier in the western hemisphere, to impede them in their progress towards the south.

The great system of lakes, indeed, which divides

[b] In the Eighth Report of the British Association for the Advancement of Science, p. 29, I have given a statement of the mean temperature of various places in North America, from the best observations I could collect, and, amongst others, of Quebec and Montreal, in the Canadas, in the parallels of 46° and 45°, and of several places in the state of New York, &c. in parallels 43° and 42°. But these results convey a very imperfect notion of the cold to which this continent is subject; its rigor may be gathered, from the failure, even in the latitudes of Philadelphia and Baltimore, of the common evergreen shrubs naturalized in

Canada from the United States, considerably moderates the cold of the winds that sweep over their surface, and thus exercises a favourable influence upon the climate of the country immediately adjoining its southern coast.

But a mere inspection of the map will convince us, how very partial their operation must be, since the whole tract, extending from the east of Lake Ontario to the Atlantic, is destitute of any such protection.

That portion of the American continent therefore which is comprehended within the geographical limits of the two Canadas, presents, wherever it has yet been explored, only a limited range of strata; but south of the great lakes, in the north-western portion of the State of New York, we find the geological features of the country somewhat more diversified.

I have already noticed the primary range, which is so developed in Essex and St. Lawrence counties, and which extends to the Hudson river at West-point, under the name of the Cattskill Mountains.

This range divides the bason of the Hudson from that of the Mohawk at Little Falls, where a chasm occurs in it, through which the river now discharges its waters.

northern Europe; from the necessity of protecting the vine during the winter in the equally low latitude of Cincinnati (parallel 39°); and from the occasional destruction of the orange and lemon (which grow without protection at Falmouth) by frosts, so low as at Charleston, S. Carolina, and even as at New Orleans.

From the register kept at Fort Diamond, Quebec, it appears, that the thermometer occasionally falls there to 40° below zero, and even at Montreal it has been seen at —23°.

But this primary chain, extending from Little Falls, on the south-east, to Kingston, in Upper Canada, on the north-west, serves as the basis, upon which the fossiliferous rocks of the west and south-west of the state repose.

These, according to Mr. Vanuxem, all dip in a southernly direction, so that as we proceed from the borders of Lake Ontario to the frontier line of Pensylvania, we get successively higher and higher in the series, till at length we reach the carboniferous system, which is so extensively developed in the latter.

The junction of the primary and fossiliferous rocks is to be seen at Little Falls, where an upheaving has taken place, which has brought the lower beds immediately resting upon the primary, up to a higher level, on the northern side of the valley, than is occupied by the newer ones on its southern.

The following, according to Mr. Vanuxem, are the rocks seen in succession in the district described in his Report for 1838.

Resting unconformably on the gneiss observed at Little Falls, is a calcareous sandstone, containing many quartz crystals and imbedded masses of anthracite.

Imperfect fucoides are the only fossils in this rock, and from this are supposed to be derived the portions of anthracite it contains.

Incumbent on this is a calcareous rock, called *bird's-eye limestone*, much used as a building stone, which is characterised by vertical stems of *fucoides demissus*.

Next occurs the limestone of Trenton Falls, remarkable for the number and interest of its

fossils[c], which appear to identify it with that of Montmorency, near Quebec, and that of Glen's Falls, below Lake Champlain.

The series of cataracts, from which this spot derives its celebrity, seems to arise from the same cause as that which produced the gigantic one at Niagara.

In both cases the limestone, over which the water abruptly descends, rests upon beds of loose friable shale, which, having been undermined by the action of the waters, deprived the incumbent limestone of its support, and occasioned the sudden termination of large masses of the latter. Hence, instead of the gradual slope, which would probably have been brought about by the flow of water over strata that opposed throughout an uniform resistance, we meet with a succession of waterfalls, caused by the precipitous escarpments which the rock presents.

The green shale and sandstone rock, which alternates with, and finally rests upon, the Trenton limestone, is characterised by various shells, some peculiar to itself, and others common also to the calcareous bed which supports it.

It is succeeded by a rock, called by Mr. Vanuxem, millstone grit, containing pebbles of quartz; and upon this reposes a series of green and blue shales, and of red and white sandstones, with oxide of iron and gypsum, which he calls the *Protean* group. The latter abounds in fucoides, but contains few

[c] The following is a list of the fossils :

Leptæna alternata,	Calymene Blumenbachii,
Delthyrus striatula,	Cryptolythus tessellatus,
Orthoceras striatus,	Isoteles gigas,
Bellerophon apertus,	Isoteles cyclops.
Favosites,	

shells; the numerous brine springs of the north of New York State rise principally through it.

Other descriptions of shale and limestone occur above, one of the newest of which contains trilobites, and other fossils of such a nature, as to identify the whole of this series, as parts of a common group, and as deposited within the same geological epoch.

The correspondence of the whole with the Silurian rocks of Murchison is confidently affirmed by Mr. Vanuxem[d]; and I have already stated, that another geologist, attached to the same corps (Mr. Conrad), even goes so far as to identify distinct beds with the several subdivisions of this formation, as it exists in our own country.

Upon the above-mentioned rocks is deposited a series of shales, sandstones, and limestones, which have been principally explored in the western portion of the state, where, owing to the general bearing of the rocks being to the northwest, the newest members of the series are found along the line of the Erie Canal, or in the country immediately to its south.

Mr. Hall, the conductor of this portion of the survey, considers these as belonging to the old red sandstone and carboniferous groups, and as lying above the Silurian system. Trilobites are found only in the lower beds of this series.

Along the Genesee river, from its embouchure on Lake Ontario upwards, a series of these rocks is

[d] who enumerates, orthocera, trilobites, producti, spirifers, pentameri, and favosites, and on the authority of Mr. Conrad, eurypterus, catenipora, conularia, and monotis, as the fossils found in it.

exposed, and a dark-coloured calcareous shale, which occurs at the Upper Falls, above Rochester, as one member of the series, has been traced to the Falls of Niagara, where it underlies the limestone, over which the waters there precipitate themselves.

The cataract itself, as is well known, occurs in the bed of the river which discharges the waters of Lake Erie into Lake Ontario; and its existence must be attributed to the sudden alteration of level which commences in the rocks above Queenstown, where they form an abrupt escarpment, rising to the height of no less than 370 feet above the alluvial ground at their base.

Now this alteration of level may have been brought about, either by a subsidence of the country to the north of Queenstown, or by an elevation of the rocks above that town to an equal extent on the south of it. The former supposition has been the one more generally resorted to, but I am more disposed to the latter, from having observed, that the strata intervening between Queenstown and Lake Erie, notwithstanding their near approach to horizontality, appear nevertheless to possess a slight inclination towards the south[e].

This may be inferred, I think, from the circumstance, that the shales which underlie the limestone of the Falls, occupy a higher level on the heights above Queenstown, than they do farther to the south; whilst other subjacent strata, which lie concealed beneath the bed of the river, on the site of the present Cataract, are here seen cropping out from beneath.

[e] See this statement confirmed by Mr. Hall, in the Report of the Geological Survey of New York State for 1838, p. 370.

Hence, as we proceed along the margin of the river from Buffalo to Lewiston, we observe in the first place, at Black-rock, a dark coloured, fœtid, bituminous limestone, full of cherty concretions, which I take to be the upper bed of the calcareous formation seen at the Falls: secondly, the subjacent portions of the latter, often dolomitic, and containing much gypsum, which are 90 feet thick at the Falls, but diminish to 20 feet at Lewiston; thirdly, the shales underlying the last mentioned rock, which may be seen sinking beneath the bed of the river at the Cataract, but rising considerably above it near Queenstown; fourthly, a white, compact sandstone, first coming into view beneath the shales on the edge of the escarpment; and lowest of all, friable beds of red marl, occupying the bed of the river, in the alluvial plain which extends from thence to Lake Ontario.

Now if we imagine the whole series of rocks, from this place to the borders of Lake Erie, to have been upheaved, we shall find no difficulty in referring to the same movement, the inclination towards the south which they likewise seem to possess—whereas a subsidence of the country, north of the escarpment at Queenstown, would rather have had a tendency to cause the rocks contiguous to slope *towards* the depressed portion of the country, than in the contrary direction.

Let us suppose, then, that an elevatory movement had taken place at some distant period, by which the country intervening between the two lakes, as far as Queenstown, attained its present position, whilst that to the north, bordering upon Lake Ontario, remained undisturbed.

Such an alteration of level would have cut off the

communication between the two lakes, assuming them to have been then in existence, or it would have ponded up the waters flowing through the valley in which Lake Erie is situated, until they had overflowed the low country above the Falls, and had reached the heights of Queenstown.

Here then, we may imagine the original waterfall to have occurred, and the cause of its retrocession, to the spot at which we now find it, must be sought for principally in the yielding nature of the strata upon which the superficial rock reposes.

The latter, as has been observed, is a compact limestone, which would yield but slowly to the erosive action of the waters; the former, a loose shale, which would be easily undermined and carried away by them.

Precipitated, as at present, over a ledge of hard rock, to a depth of 164 feet, this sheet of water, when it struck the pool beneath, would send forth a blast of spray and wind, which, striking against the crumbling shale beneath, would gradually disintegrate it; until the incumbent limestone, deprived of its support, itself fell, and the Cataract consequently receded.

Such is the course of operations witnessed at the Falls at present, and such must have been the case from the time the Cataract began to exist, whatever may have been the point at which it originally stood.

Writers, in general, have agreed in fixing for this spot upon the heights above Queenstown, and upon this assumption have speculated upon the length of time that would have been required, for the recession of the Cataract to its present site near the village of Schlosser, 7 miles distant.

It has been calculated, that the present rate at which the Cataract recedes, is about 50 yards in 40 years, so that it would have been nearly ten thousand years in falling back to its present point, and would require 36,000 more before it reached Lake Erie, the nearest point of which is still 25 miles to the south of it.

But it must be confessed, that all the points here laid down are assumed on very insufficient grounds, and may each of them admit of dispute.

In the first place, granting that the Cataract originally stood at Queenstown, granting that its present rate of retrogression is correctly stated, and granting moreover, that it has been at all former periods the same as it is now observed to be, still it by no means follows, that it will continue to travel backwards at the same average pace hereafter.

For this to happen, would imply, not only a degree of resistance in the superficial stratum, as nearly as possible corresponding to that which it opposes to the action of the water at present, but likewise the existence throughout of the same friable shales underneath it, at such a level, as would allow of their being attacked and undermined, as they are now, by the spray proceeding from the Cataract.

Now the latter supposition will appear an extremely improbable one, from what has been already stated with respect to the dip of the strata, which must cause the shale to sink below the bed of the river, before it reaches the site of Lake Erie.

A still further retrogression of the Cataract (observes Professor Rogers[f]) will bring the Cataract altogether out of the inferior shale, the thickness of which is at present only 90 feet, and when that is the case, the further action of the waters upon the

[f] Silliman's Journal, vol. 27, on the Falls of Niagara.

surface of the limestone, will produce a series of rapids or minor falls, and not a single stupendous one as at present.

But it has even been questioned, whether in point of fact the waterfall ever stood so far back as the heights above Queenstown, and recently a correspondent in Silliman's Journal [g] maintains, on distinct and independent grounds, that the most remote point at which it could ever have existed was not more than three miles below its actual position.

If such however be the case, we must assign some cause for the scooping out of the deep and precipitous ravine, which extends from the supposed point to the termination of the high ground above Queenstown, distinct from the action of the river which now occupies it, and here I am not quite satisfied with the explanation given.

At any rate, these rocks would seem to have been elevated at some period, geologically speaking, not very remote, for otherwise we might expect, that they would ere this have been scooped out by the action of the waters as far as the shores of Lake Erie, and we should now behold a succession of rapids along the whole extent of Niagara river, instead of one abrupt fall of water, as at present, between the two Lakes.

It seems hardly necessary for me to enlarge upon the inconsistency of the above statements, with a theory that has been advanced by certain geologists, who have suggested the probability of an enormous flood deluging the surrounding country at some future period, owing to a sudden drainage of Loch Erie, which is to be brought about by the retrocession of the cataract to its borders.

[g] Mr. Hayes on the Geology of Western New York State.

But, I may add, that even if we grant that the cataract will work its way back to this distant point, it by no means follows, that a sudden drainage of the lake will be the consequence, since (as Mr. Delabèche, and others[h], seem to me to have satisfactorily shewn) the volume of its waters will have previously been much reduced by the gradual drainage of it, which will begin to take place, so soon as the cataract shall have receded to a point on the *plateau*, over which it falls, where it will stand at no higher level, than that of the upper surface of the existing lake.

I shall however refer to Mr. Delabèche's Manual[i] for a more full and clear exposition of this part of the subject.

With respect to the Fall itself, considered in a picturesque point of view, or as influencing the imagination and feelings, it may seem an odd confession to make, that my first feelings on visiting it were not unmixed with disappointment.

Of an object so long known by report, each person, before he reaches the spot, conjures up in his mind some sort of idea, which in certain respects must differ from the reality, and may therefore lead him to imagine the latter as falling short of his previous conceptions.

Thus I had imagined, that the fury of the waters, after they had been launched over the cataract, would have been more terrific, and was surprised at seeing the ease, with which an insignificant ferry

[h] See H. Rogers on the Falls, Silliman's Journal, vol. 27.

[i] Third edition, p. 59.

boat crossed the stream within a very short distance below[k].

The noise produced by the waterfall itself, I had also conceived, would have been more stunning; and it was with a feeling nearly allied to what one might entertain, at hearing a person of solid weight and character talked down by a noisy upstart of yesterday, that I found the roar of this stupendous natural phenomenon overpowered by the hissing of a Locomotive, which was letting off its steam at the railroad station adjoining.

The presence of these evidences of human ingenuity was in other respects also very unpropitious to the feelings which the scene itself was calculated to inspire, and though no enemy either to railroads or factories in their proper place, I could have wished all vestiges both of the one and of the other banished from a spot, where nature ought to be allowed to reign undisturbed and alone.

But after a time, these first prepossessions wore away, and I then began to feel more impressed with the solemnity of the sound which the cataract produces in its descent, than I had expected to have been by the deafening tumult of waters for which my imagination had prepared me.

In surveying it too under various aspects, and at different distances, I found new sources of admiration and astonishment continually presenting themselves, of which I had previously no conception; nor did the interest of the scene appear to flag, when I turned to contemplate the phenomena presented in the course of the river both above and below,

[k] This however is owing to the backwater, which counteracts in a great degree the force of the current.

which may be regarded either as concomitants, or as consequences, of the cataract itself.

Writers indeed have spoken of the scenery in the neighbourhood of the Falls as tame and uninteresting, but they cannot mean to extend this remark to any portion of the river itself, which, from its origin at Buffalo to its termination in Lake Ontario, presents everywhere a succession of the grandest and most striking objects.

To begin with the point at which it terminates in Lake Ontario.—From the above spot to Queenstown, where we meet the escarpment at which the cataract has been supposed to have originally stood, the river meanders beautifully through a level country, within a wide channel, and with a current comparatively slow, so that thus far steamers meet with little difficulty in ascending it.

But from the commencement of the cliffs at Queenstown to the Falls themselves, the river is hemmed in by deep precipitous banks, and flows with a rapidity, which even from the first is greater than any machinery can contend against, and which becomes still farther augmented higher up. On reaching a point in its course about three miles below the Falls, the foam and noise of the waters indicate the increased violence of the current, and here, in consequence of a bend in its channel, by which the stream is deflected from its direct course both to the right and left, occurs the whirlpool, in which objects once committed to the waters are either carried round and round with great velocity for an indefinite period, or, being sucked into the eddy at the centre, are drawn down to a great depth.

At this point opens the first view of the Falls from below, and it is perhaps one of the best sta-

tions from whence to contemplate them, in consequence of the two masses of water, which are seen separately on approaching nearer, being at this distance blended into one, and appearing like one continuous sheet of foam, shining and sparkling in the sun's light.

Arrived at the village on the American side opposite the Falls, which goes by the very unromantic name of Manchester, the first object that attracts our notice is the eastern branch of the Niagara river, rushing with the greatest impetuosity down to the point, where it is precipitated over a reef of rocks, and constitutes what is termed the American Fall.

This branch of the stream is divided from the Western or British, by Goat Island, a small tract of land standing up in the midst of the waters, based on the limestone ledges which form the rapids, but composed below of loose alluvial deposits, which could offer no effectual resistance to the current, if the latter had not been turned aside from them, both on the right and left, by the hard calcareous rock which bears the direct brunt of its violence.

Goat Island is connected to the main land by a wooden bridge, thrown across the rapids, of a very bold construction, by means of which, we are enabled to avail ourselves of the many favourable positions for contemplating the rapids and the cataracts, which its centrical position affords.

A staircase, enclosed in a kind of wooden tower, which descends to the very level of the river, enables us to reach the water's edge between the two Falls.

Here, when the wind blows the spray in the reverse direction, it is practicable to proceed a certain distance under either sheet, and thus to obtain a

near view of the waters dashing over the cliff, whilst we stand in the space between them and the rock.

Seen by the light of the sun transmitted through them, they appear perfectly sea-green, until having descended the precipice, they become dissipated in foam.

Perhaps, however, the view of both Cataracts from a little greater distance, surpasses it in beauty, especially when the sun shines brightly enough, to produce in all their brilliancy the hues of the rainbow, which it occasions in the mist arising from the spray of the descending waters.

> On the verge
> From side to side, beneath the glittering morn,
> An Iris sits, amidst the infernal surge,
> Like Hope upon a death-bed, and unworn
> Its steady dyes, while all around is torn
> By the distracted waters, bears serene
> Its brilliant hues with all their beams unshorn:
> Resembling, 'mid the torture of the scene,
> Love watching Madness with unalterable mien.

Such are the most striking features exhibited on the American side; but the views obtained on the Canadian are perhaps of a still more sublime character.

At the Table Rock, where the removal of the subjacent shales has occasioned the solid limestone to project several feet forwards, we may approach almost within reach of the Horse-shoe Fall, and contemplate at our leisure the waters of this, the more considerable portion of the Niagara River, beating over the face of the precipice, and precipitated to a depth of more than 160 feet.

Or we may descend the cliff over which the waters are projected, and accomplish, with no other

risk than that arising from a thorough wetting, the apparently formidable undertaking of passing behind the falling waters, in the interval between them and the face of the rock.

The whole effect of the scenery at the Falls was enhanced by the height and abruptness of the banks on both sides of the river, and, at the season I visited the spot, by the exceeding richness of the autumnal tints exhibited by the trees that hang over the face of either cliff.

It was, as if the fissure in St. Vincent's Rocks at Clifton, now occupied by a dark, muddy river, which looks like the outscourings of a large commercial city, had given passage to a deep pellucid stream, which, instead of flowing languidly along its oozy bottom, was urged with impetuosity over projecting masses of rock, foaming and roaring in its course, and finally precipitated to an immense depth over a perpendicular cliff.

Add to this, the greater dimensions of the channel, and the larger volume of the water it contains, being indeed the whole of that immense tribute, which the lakes, or rather seas, of Erie, Huron, Superior, and others, are pouring into the lap of the Atlantic.

Formerly it might have seemed hyperbolical, to have pronounced a sight of the Falls, as in itself worthy of a voyage across the Atlantic; but at present, when steam navigation has in a manner shortened by more than one-half the distance that separates the two hemispheres, it is not too much to affirm, that a visit to Niagara, coupled with a view of the enchanting scenery presented in the journey to it, will afford to most European travellers an

ample compensation for such discomforts, as may be calculated upon during a summer passage to America.

But to proceed with subjects more immediately connected with the purport of this Memoir. It seems pretty evident, that a considerable sinking of level must have taken place in the waters of the Great Lakes. This is proved by the terraces, (or ridges, as they are perhaps less properly termed in America,) which are more or less distinctly seen, extending along either shore of Lake Ontario, as well as of Lake Erie.

The height of the terrace above Lake Ontario, in Niagara county, is about 160 feet, and its position is nearly parallel to the present shore of the Lake, which is from four to eight miles distant. It is composed of sand, gravel, and pebbles, similar to those forming the beaches along the present Lake shore, and its existence can only be explained, by supposing the water of the Lake to have once stood at that level.

I travelled on this ridge, which forms an excellent natural road, all the way from Lockport to Rochester, and observed one similar, though less distinctly marked, at a certain height along the borders of Lake Simcoe.

Having now described some of the principal formations that rest on the flanks of the primary ridge, in the northern portion of the Union, I next proceed to notice those which occupy the same relative position, in the States of New Jersey, Pensylvania, and Virginia.

In the first of these countries Professor Rogers has described a series of strata, resting upon the primary rocks of the Blue Ridge, and yet all dipping under the coal formation of Lehigh, in Pensylvania.

The uppermost formation, or that nearest to the coal, may be described as a triple series, consisting of a dull bluish slaty limestone, abounding in organic remains; of a bluish, sometimes reddish, calcareous slate or shale; and of a grey, and sometimes slaty sandstone.

The limestone contains many organic remains: shells of the genera Productus, Spirifer, Unio, &c.; Cyathophylla, and other Zoophytes; together with more than one undescribed species of Trilobite.

This upper formation rests on beds of red and grey sandstone, underneath which is a series, consisting of at least two slate and two limestone formations, in apparently regular alternation.

The most remarkable circumstance relative to these beds, is the conversion of the ordinary blue limestone, into white crystalline marble, where it approaches the gneiss.

In Orange County, for about 25 miles in extent, occurs a range of this material, containing various interesting and rare minerals; such as Franklinite, Red Oxide of Zinc, Spinel, Brucite, Ceylonite, Tourmaline, &c.: in all, no less than 43 species.

The metalliferous veins, it may be remarked, are directly at the junction of the crystalline limestone with the primary strata.

In various parts of what are called the Highlands of New Jersey, beds of limestone occur, enclosed between the primary ridges, with similar characters.

The limestone has often much the appearance of the Tiree marble of the Hebrides; but the mineral principally disseminated through it is Graphite, which pervades it, in glossy black specks of the size of a pin's head, and upwards.

The sandstones and shales are likewise much indurated for several hundred feet from the Trap Dykes that penetrate them; and several interesting minerals are met with in the altered portions.

Farther to the South, the series of formations, extending from the Blue Ridge to the valley of the Mississippi, is at present undergoing examination from Professors William and Henry Rogers: the former of whom has already published three successive, but brief, reports on the Geology of the State of Virginia, and the latter, two similar ones on that of Pensylvania.

In these publications the authors agree in distinguishing no less than twelve rock formations; the lowest of which is incumbent on the rocks of the Blue Ridge, and the highest supports a coal formation, which, from the character of its vegetable impressions, has been regarded as corresponding in age with that of the slate coal of England, and other European countries.

If the latter proposition be admitted, it is evident, that the rocks, upon which the coal reposes, and which form the immediate subject of the Professor Rogers' examination, are either the *same* as those of the Silurian system of Great Britain, or at least bear the same relation to the coal field of America, which the Silurian rocks do to that of England; and it would be superfluous for me to point out the importance of determining whether the former or the latter of

these suppositions be the true one: considering that the whole question, as to the uniformity of the older deposits in distant portions of the globe, hinges upon it.

Unfortunately, the data for this inquiry are still wanting; no complete lists of the organic remains found in the rocks of the Alleghany mountains having yet been presented to us; and, when they have been noticed, the genus only of the fossil having, in many instances, been decided on.

The deposits alluded to, form, in general, a more elevated portion of the Alleghany chain, than the unstratified rocks that constitute the Blue Ridge, and lie exclusively to the north-west of the latter; no strata in this part of the country, belonging to the above series, or of equal antiquity with it, being found to the east of the Blue Ridge.

A concise description of these several formations has been given by Professor William Rogers, in his two latter memoirs; but we owe to his brother a more compendious view of the whole series, contained in the second annual Report on the Geological Exploration of Pensylvania; which will represent the succession of strata developed in the one, as well as in the other, of these neighbouring states.

I shall therefore subjoin the Table, as it stands, with no addition, but that of appending to it, in a separate column, the localities, in which, according to Professor W. Rogers, the corresponding strata are seen best developed within the confines of Virginia, and with no further remark as to its contents, excepting to point out the enormous aggregate thickness of these deposits, which, though belonging to only one geological epoch, amount to at least 40,000 feet.

Table shewing the Order of Stratification, Geographical Position, Composition, and the Maximum Thickness of the Lower Secondary Formations of Pennsylvania, east of the Susquehanna river.

ormations in the scending order.	*Geographical Position.*	*Usual Composition.*	*Maximum Thickness.*	*Where best seen in Virginia, according to Prof. W. Rogers.*
XIII.	Anthracite coal basins.	Dark blue shales, bluish grey argillaceous sandstones, and coarse quartzose conglomerates, and seams of Anthracite coal.	6750 ft. nearly at Pottsville. Not yet positively ascertained.	Between the Ohio river and the top of Little Sawell mountain.
XII.	Sharp mountain, and the other mountain barriers of the Anthracite coal basins.	Coarse quartzose conglomerates, alternating with white and grey sandstones, and occasional thin beds of dark carbonaceous shale.	1400 feet. Tamaqua.	Near Lewisburg, Greenbrier county.
XI.	Surrounds the mountain barriers of the Anthracite coal basins, usually in a narrow valley, immediately outside of them.	Red shales and soft argillaceous red sandstones, and occasional beds of compact siliceous red and grey sandstones, also a few thin calcareous bands.	2949 feet. Mt. Carbon.	Expands to a wide area in Pocahontas, Greenbrier, and Monroe counties.
X.	Second mountain, Peters's mountain, Mahantango mountain, Berry's mountain, Line mountain, Little mountain, Cattawissa or Nescopeck mountain, Wyoming mountain, Shickshinny mountain, and the south-eastern summit of the Allegheny mountain.	White and grey siliceous sandstones, with dark bluish and olive coloured slates, also coarse siliceous conglomerates, alternating with grey, yellow, and white sandstones, and bands of black carbonaceous slate; the latter sometimes erroneously taken for coal slate.	2400 feet, very nearly. Second mountain.	Between the Greenbrier river, and the White Sulphur spring.
IX.	Occupies the north-west part of Pike and Monroe, the eastern part of Wayne, all except the northern side of Susquehanna county, the whole south-east side and base of the Allegheny mountain, and the bases of the mountains consisting of Formation X. on the sides remotest from the Anthracite coal basins.	Red shales and argillaceous red sandstones, also brown, greyish, and buff coloured sandstones.	6000 feet, or more. Below Mauch Chunk, Lehigh.	Hampshire county, Shenandoah or Branch mountain.
VIII.	Middle of the valley between the Kittatinny and Second mountains, valley of Delaware river from Water Gap to Carpenter's Point, middle of Roaring Creek valley, North Branch, from Bloomsburg to Berwick, Muncy hills.	Alternating strata of dark grey, greenish, and olive coloured slates, and grey argillaceous sandstones. Contains many fossils. A stratum of blue fossiliferous limestone near the bottom of the formation.	5000 feet, at least. Below Mauch Chunk, Lehigh.	Ridges of the Allegheny mountain, as in Warm Spring valley, and near White Sulphur spring.
VII.	The sharp rugged ridge next north of the Kittatinny mountain.	A coarse and rather loosely cemented white and yellowish sandstone, with cavities, shewing the forms of shells, and other organic remains.	700 feet. Susquehanna river, Dauphin county.	Mountains in Hampshire, Hardy, Pendleton, Bath, Pocahontas, and Allegheny counties.
VI.	A very narrow belt occurring in places along the northern base of the Kittatinny mountain, and thicker strata along both the northern and southern bases of Montour's ridge.	A blue argillaceous limestone, sometimes grey and sandy, and frequently very full of fossil shells, encrini, &c.	900 feet. Fishing creek, Bloomsburg.	Knobly, Patterson's creek, Bull-pasture mountains &c., Cow-pasture valley.
V.	Northern base of the Kittatinny mountain, and on the sides and summit of Montour's ridge.	Red and variegated sandstones and shales. The lowest layers abound in several species of the marine vegetable fossils called *fucoides*.	2000 feet, at least. Delaware Water Gap.	Hardy and Hampshire counties.
IV.	Kittatinny or Blue mountain.	Hard white and grey sandstones, and coarse massive quartzose conglomerates. Contains impressions of several species of *fucoides*.	1886 feet. Lehigh Water Gap.	Great North mountain, west of Rockingham and Shenandoah counties.
III.	Northern side of the Kittatinny valley.	Dark fissile slates, usually blue, dark grey, black, and dingy olive, and sometimes drab, yellow, and red. Contains also some beds of sandstone, and a few of conglomerate.	6000 feet, at least. Delaware river, below the Water Gap.	Base and flanks of the Peaked mountain, and the Massanutten &c. in the counties of Rockingham, Page, and Shenandoah.
II.	Southern side of the Kittatinny valley.	A blue limestone, with thin interposed layers of chert.	6000 feet. Not yet ascertained, but probably as much as stated.	West and north of the Blue Ridge.
I.	Southern margin of the Kittatinny valley, and northern side of the chain of hills called the South mountain.	A very compact, rather fine grained white and light grey sandstone.	Not ascertained, but probably 1000 feet.	Western slope of the Blue Ridge.

Now, in Virginia, these several formations are tilted up on either side of an anticlinal axis, which lies at a distance from, and has no connexion with, the older rocks of the Blue Ridge. Thus they rather abut against the latter, than rest upon them, dipping at first to the east, so that they might appear to sink beneath them, and, in spite of many irregularities in the stratification, the general tendency continues to be towards the same point, as far as the line at which the anticlinal axis is situated.

A large portion of the country occupied by this series of rocks constitutes the rich and beautiful valley of Virginia, in which the towns of Staunton, Lexington, &c. are situated.

West of this anticlinal line, the same series of rocks is repeated, but with the general tendency of the stratification reversed, the rocks dipping for the most part, excepting in the case of partial disturbances, to the west, and, as on the other side of this central line, being most tossed about, and most highly inclined near to the anticlinal axis, and becoming gradually more and more horizontal as they recede from it.

It will be perceived from the Table already presented, that the rocks, which the Rogerses distinguish in the tract of country under their examination, have not as yet received from them any characteristic appellations, their identification with European rocks still remaining to be accomplished; although, as has been already remarked, the newest in the series seems to correspond, both in character and in organic remains, with the carboniferous system of England, which it rivals in the abundance of the coal distributed through it, along

the whole of the line of country occupied by it, from Ohio to Tennessee.

In Pensylvania, the bituminous coal formation appears to bend round to the north-west, extending from Pittsburgh to Towanda, on the borders of the state of New York, and occupying the same relative position, as in the neighbouring state of Virginia.

The whole of this district has been noticed by Dr. Hildreth, in a late number of Silliman's Journal; and it appears from his description that the coal-beds vary from one to twelve feet in thickness, rarely, however, exceeding six feet; that they lie in nearly horizontal strata, with a slight inclination westwards; that they embrace an area of 24,000 square miles, constituting, perhaps, the largest known accumulation of carboniferous matter in the world; and that they usually rest upon sandstone, which appears often to be strongly impregnated with salt.

The vegetable impressions, which he has delineated, as occurring in the coal and accompanying shales, appear to identify the age of this coal with that of our own country.

These, however, are by no means the only situations in which coal exists in the countries alluded to, for extensive deposits of this mineral are found in the immediate proximity of the primary unstratified rocks of the Blue Ridge.

Such is that of Pottsville, which commencing near to the Lehigh, and filling up the valley between the Sharp and Broad Mountains, terminates some miles east of the Susquehanna, and is about sixty miles long, its greatest breadth being five miles.

Another coal field, similarly related, is that of Shamokin, which commences near the Lehigh at Buck Mountain, and terminates at the point of junction of the Big and Little Mahony, being of about the same width as the former.

A third is that of Wilkesbarre, which commences near to Carbondale, and terminates at the Susquehanna, near Nescopeck[a].

Now it is to be remarked, that all these coal fields are *anthracitic*, or destitute of bitumen; whilst those to the westward of the chain are always bituminous, so that the chemical composition of the coal seems determined by its geological position[b].

There is one peculiarity in the series of rocks just described, which may serve to distinguish them from those of a similar age in Europe, namely, that copious brine-springs gush out every where, from underneath the coal formation, and not from strata of newer date. Such is the case with the brine-springs near Pittsburgh, as well as with those in the state of New York; nor is there any reason for assigning a more recent origin to any of the very numerous saliferous

[a] I am indebted for these particulars to my friend, Mr. Lea, of Philadelphia.

[b] Dr. Hildreth remarks, that as we approach the coal-beds in the transition and primitive rocks, the evidences of heat are more apparent, removing from the anthracitic beds, all, or nearly all, their bituminous contents, and in the primitive, changing anthracite into graphite or plumbago. A less degree of heat has been applied to the bituminous rocks of the Ohio, for they are far removed from any crystalline or transition rocks on which the marks of heat are so apparent, and therefore could not receive a sufficiency, to deprive them of their bituminous principles, and change them to carbonaceous coal-beds.

deposits, which, judging from the frequency of springs impregnated with this ingredient, appear to be distributed throughout the interior of this continent.

Near Pittsburgh, the brine-springs rise from a depth of about 270 feet; on the Connemaugh River at about 500 feet. They are usually accompanied with a disengagement of carbonetted hydrogen gas, which may, however, proceed from the bituminous shales and coal-beds, which rest upon the muriatiferous sandstone.

The brine-springs, which occur in this position in the United States, appear to contain the same ingredients which are common in those of European formations.

I myself detected iodine very copiously in the mother-water from the salt-works of Syracuse, in New York State; and I find that it has been met with also in the salt springs of Pensylvania.

Bromine I could not discover, but the quantity of the sample which I had brought away was too small, to justify me in inferring the entire absence of this principle from the water experimented upon.

The rocks, from which these springs issue, appear to be accompanied, as in Europe, by very large beds of gypsum, which occurs in irregular, often conical masses, enclosed in a greyish friable marl. This marl is probably impregnated with saline matter, which it imparts to the water that percolates it; for no beds of rock salt have hitherto been found in the state of New York, although frequent sinkings have been made in the saliferous strata, in the hope of discovering it; nor indeed ought brine-springs to be considered as affording any certain

indications of its existence, where, as in this case, they are so fully impregnated with the more deliquescent ingredients, which are found in sea-water, but which are altogether absent from beds of rock salt.

If our information with respect to the geology of the eastern states is imperfect, it can hardly be expected, that I should have been able to procure any precise, or detailed account, of the rocks observed in the less explored regions of the west.

The conductors of the geological survey of the State of Ohio, (amongst whom I recognise with pleasure the name of my kind and intelligent friend Professor Locke,) have, however, as I collect from a notice in Silliman's Journal, published their first annual report, in which they have noticed, amongst other formations, a great limestone deposit dipping under the coal, which they regard as the equivalent of the mountain, or carboniferous, limestone of Europe. It is first found in Adams county, and extends thence to the western borders of the state.

Now I have little doubt, but that this is the rock which I had observed in various parts of Kentucky, as near Lexington, Frankfort, &c., and which I afterwards found so replete with petrefactions just above the city of Cincinnati, where it occurs, in great thickness, in strata nearly horizontal, and alternating with beds of marl.

From its general appearance, and from a cursory inspection of its imbedded fossils, I remarked its resemblance to the Dudley limestone of England; and on my return to England, I submitted the spe-

cimens obtained from it, first to Mr. Murchison, and afterwards to Mr. Lonsdale.

Mr. Murchison recognised several of the fossils as resembling those of his own Silurian system, and Mr. Lonsdale, after the more detailed and careful examination to which he has been good enough to subject them, has completely confirmed this suspicion.

The rock at Cincinnati, I may observe, is filled with a profusion of Corals, of Bivalves, and of Trilobites.

The branched Coral which I sent him, Mr. Lonsdale considers to be the *Favosites spongites* of Goldfuss, Tab. 64—70, the tuberculated surface, which it presents, being due only to irregularity in the growth of the animal, there being no characters on which a specific distinction can be founded. In some instances the surface is quite smooth, and a passage from that state to the roughly tuberculated one may be traced in the series of specimens. Now, as may be seen by Mr. Murchison's work, the *Favosites spongites* is an abundant Silurian coral.

Of the shells brought by me from Cincinnati, one appears to be the fossil figured in the same publication, as the "Orthis pecten" of Dalman. Mr. Murchison's specimen is taken from the Caradoc sandstone, and Dalman's probably from some portion of the Silurian system. Mine is the shell belonging to the Genus Strophomene of Raffanesque.

The other shells have in general the character of Silurian fossils,—they belong to the Genera, Atrypa, Orthis, Spirifer, Leptæna (Productus), Terebratula, and Euomphalus; but although in many of them the resemblance was strong with species figured in

Mr. Murchison's work, I have not sufficient confidence in my power of discriminating minute conchological differences, especially in the case of specimens hastily collected, and therefore not always in the best state of preservation, to venture to pronounce on their identity. Encrinital stems are abundant, and there is likewise the portion of a Calymene.

Under this rock is the coal formation of Ohio, the extent of which may be in some degree appreciated from the estimate made, namely, that the whole amount of coal in Jackson and Lawrence counties would be sufficient to form an entire stratum of 50 miles in length, 5 miles in width, and 9 feet in thickness, yielding about 9,000,000 of tons per square mile.

After this sketch of the geological structure of the Continent, so far as it is yet brought to light, we may be better prepared to understand the position occupied by the Thermal Waters, that have here and there been discovered.

The following appear to be the only ones exceeding the mean temperature of the climate, which have as yet been noticed :—

In the State of New York, 20 miles east of Albany, near the Shaker's village of Lebanon, occurs a spring possessing a constant temperature of 73° Fahr.

It emerges from the junction of talcose slate with an impure schistose limestone, containing, though scantily, organic remains, namely, five species of Fucoides, Trilobites, &c. There is a fault in the vicinity of the springs.

This thermal water has been frequently analyzed, but nothing of importance has been detected in its composition: it emits copiously bubbles of gas, which I examined on the spot, and found to contain no trace of carbonic acid, but to consist of nitrogen 89.4, oxygen 10.6.

In the same chain, as we proceed into the State of Vermont, we meet with one or two other slightly thermal waters, as at Williamstown in that State, and at Canaan at the foot of the Green Mountains.

I am disposed also to consider the carbonated waters of Ballston and Saratoga, which lie about 50 miles to the N. W. of Lebanon, as slightly thermal, for by reference to the Table, published by the Regents of New York University, it will be seen that Schenectady, the nearest post to these springs at which observations are recorded, and situated a little to the south of them, possesses a mean temperature of only 46.20 Fahr.

Now I found at Ballston, one of the springs to be 50.5°, and the other 49.5°; and at Saratoga, the new Congress Spring, 49.5°, Hamilton Spring, the same, and the old Congress Spring, 51°. At both these localities gas was given off, consisting chiefly of carbonic acid, but containing, after this had been removed in the usual way, a residuary portion of air, in which nitrogen and oxygen were both present, but with an excess of the former, as compared with the proportion existing in the atmosphere.

Springs evolving nitrogen gas are also found in the south-east corner of the township of Hoosick, in Rensselaer county in the state of Vermont. The gas is stated to be pure, and is evolved in great abundance, but the temperature of the water does

not appear to vary from that of the springs in the neighbourhood.

Of the same description are those of Chateaugay, in Franklin county, New York state. The gas issues abundantly, but the water does not rise above 40° Fahr., even in summer.

South of the Seneca falls, near the village of Cayuga, there gushes out from a fault in the limestone a copious spring of pure cold water, which is kept in a state of violent ebullition from the escape of nitrogen gas. This is the only instance of such a phenomenon in the midst of calcareous rocks, all others (says the author of the Report) known in the state of New York being near the junction of transition with primitive, or with metamorphic rocks.

The next group of thermal waters I shall notice is that which occurs in Virginia, and here I am indebted to professor William Rogers, for directing my attention to the geological structure of the country immediately bordering upon these springs, which I found to be strikingly corroborative of the views I had some time ago announced, with respect to there being a general connection between the occurrence of thermal waters, and of extensive disturbances or dislocations in the strata adjoining them[g].

g For a full detail of the facts which have led me to this conclusion, I may refer to a memoir on Thermal Springs, in the Edinburgh New Philosophical Journal for 1831, and for a brief summary of the same, to my General Review of mineral and thermal waters, in the 6th Report of the British Association for the Advancement of Knowledge.

In the midst of the beautiful mountain region of Virginia, west of the Blue Ridge, but in that part of the chain which attains the highest elevation, and possesses the most picturesque character, is situated an assemblage of mineral waters, which, from their reputation as medicinal agents, as well as from the purity and coolness of the air which surrounds them, attract every summer, from all parts of the Union, and especially from the southern sections of it, crowds of persons, in search either of health or amusement[h].

Several of the most noted of these seem to possess the ordinary temperature of those in the neighbourhood, and to derive their efficacy from the sulphuretted hydrogen with which they are impregnated; such are the White, the Red, the Blue, and the Salt, Sulphur Springs.

The three former acquire their distinctive appellation from their colour, the difference in which is probably attributable to that of the confervæ, that grow in them, and impart their respective hues to the water; the latter, designated as the Salt, owes its name to the presence in it of a larger proportion of common salt, than in the rest.

One, "the Sweet Spring," is strongly acidulous, and slightly thermal, but two, which appear to possess no remarkable mineral impregnation, are designated by the names of the Warm and the Hot Spring, from the more or less considerable elevation of temperature which belongs to them.

[h] For an entertaining account of these springs, and of the journey to them, I may refer to a little guide book, published by my friend Mr. Philip Nicklin of Philadelphia, entitled, "Letters descriptive of the Virginia Springs by Peregrine Prolix, 1837."

The Warm Spring I found to possess a heat of 96° Fahr., the Hot Spring one of 102°, whereas the mean of the climate appears to be about 56°.

Both springs emitted bubbles of gas in considerable abundance, of which I collected samples.

That from the Warm Spring was found to contain, 6 per cent of carbonic acid, 94 per cent of nitrogen, and only 6 of oxygen; that from the Hot Spring varied a little according to the source from whence it was taken: the gas obtained from the ladies' bath consisting of, 11 per cent carbonic acid, 98 per cent nitrogen, 2 per cent oxygen; and that from the men's bath, 8 per cent carbonic acid, 96 nitrogen, and 4 oxygen. These proportions are computed on the assumption, that an expansion of 2 per cent takes place in nitrogen, after phosphorus has been heated and volatilized in the vessel that contains this gas.

Now both the above springs lie at a distance of about three miles one from the other, in a valley, the direction of which is nearly north and south, and it may be seen by reference to the section, which professor William Rogers has appended to his Geological Report of the State of Virginia, for 1836, that they are situated exactly at the anticlinal axis already alluded to.

And on examining the rocks on both sides of these springs, wherever the nature of the country allowed of my exploring them, I found every reason to place reliance on the correctness of his representation.

To the west of the Hot Spring, the more southern of the two thermal waters alluded to, the rocks become more and more inclined towards the west,

as they approach nearer to it, until at length in its immediate vicinity they assume an almost vertical position.

Immediately surrounding the spring, which issues from the bottom of the valley, are vertical beds of a blue fossiliferous limestone, called No. 2. by professor Rogers, being the lowest but one of the rocks incumbent on those of the Blue Ridge, which are included in his series.

A very compact sandstone, used as a freestone, succeeds, then beds of clay-slate again, and afterwards an highly ferruginous sandstone.

Up to this point, the rocks are inclined at so high an angle, that they may be regarded as vertical, and, in consequence of being so near the axis of the movement, they are often contorted and much disturbed.

Farther to the west, however, they are succeeded by strata, of sandstone, conglomerate, iron stone, and clay-slate, dipping at a gradual decreasing angle of inclination, and this continues to be the case until they become nearly horizontal.

On the east of this spring, the density of the forests is such, as rendered it impossible for me to obtain any knowledge of the mineral structure of the subjacent rocks, but this desideratum was supplied, by following the road running to the east of the Warm Spring, which, as I have already stated, lies in the same valley.

Here, as we ascend the so-called Warm Spring Mountain, we observe the very same rocks successively presented to us, which we had seen to the west of the "Hot Spring;" and these equally ver-

tical in the immediate neighbourhood of the spring, dipping in the reverse direction, and at a high angle, farther to the west, and at length subsiding to a moderate inclination at a still greater distance from the axis of elevation.

Such are the circumstances, which were originally communicated to me by professor Rogers, and which I had myself the satisfaction of verifying on the spot; and I am the more pleased in communicating them, as they supply another, and that a striking example, in addition to those I have adduced from other parts of the globe, of the connection of thermal springs with great physical disturbances.

To these particulars I may add, that the Sweet Spring, the only other instance of a thermal water which this country exhibits, is situated, according to professor W. Rogers, in a locality, which evinces a considerable disturbance in the strata, as is represented in the section appended to his Report.

In Buncombe county, North Carolina, in the midst of a mountainous region, occurs a thermal water, possessing a temperature of 125° Fahr.

The rock from which it gushes, according to professor Vanuxem, is the calciferous sand-rock, the earliest member of the Silurian system, or that resting immediately on the primary.

The layers of the rock are very irregular, more or less vertical, and of a white colour, but at a little distance to the west, they present their blue colour, common to the rock where the lime is in excess, and their well defined parallel lines of separation dipping to the east.

The calciferous, with the primary rocks to the east, form a synclinal (anticlinal?) line, as is the case near the hot springs of Virginia[h].

To the west of the Alleghanies, in the state of Arkansas, at a distance of more than 200 miles west of the Mississippi, not far from the river Washita, is another group of thermal waters, which I took occasion to visit in the course of last spring.

They are very numerous, bursting out from the side of a steep acclivity, which they have in process of time incrusted over with a thick coating of stalagmitic matter.

It is remarkable, that the travertine, which the springs formerly deposited, is different in colour and appearance from what they produce at present; the former being dark looking, and containing a portion of iron, as well as of calcareous matter; the latter quite white, and consisting entirely of carbonate of lime.

The springs vary considerably in temperature, the hottest being 148°, the coolest 118° Fahr., according to my observations[i].

They contain very little mineral matter, a pint evaporated to dryness yielding no more than 1.8 gr. Of this, one half was carbonate of lime, and one fifth of a grain, silica. The rest was chiefly common salt, but there was a mere trace of sulphuric acid, when the water had been much concentrated. One of these springs deposited an ochreous precipitate,

[h] Second Annual Report on the State of New York for 1838, p. 260.

[i] They are stated however in Silliman's Journal as rising as high as 154° or 156°.

and gave indications of iron when tested. The remainder were entirely free from that ingredient.

Most of the springs emitted bubbles of gas, which, according to my experiments, consisted of carbonic acid 4 per cent, nitrogen 92.4, oxygen 7.6.

The rock, which forms the basis of the hill, from which the thermal springs of Washita issue, is a bluish fissile clay slate, dividing into nearly vertical laminæ. Incumbent upon it, however, are beds of chert, quartzy sandstone, and flinty slate, from the junction of which with the clay-slate the springs appear to gush out.

The prevailing rock, however, in the neighbourhood of the springs, so far as my observation extends, is quartz-rock, sometimes assuming the character of whetstone-slate, and in one locality, (situated within a few miles of the springs,) quarried for hones; but constituting a part of the same extensive formation, which I have represented myself as having followed, from Little Rock, in Arkansas, to St. Louis, in Missouri[k].

The chain is regarded by geographers as a branch

[k] It may be useful to those travellers, who, perchance are meditating a similar excursion, and it at least is only just towards the settlers, on whose hospitality and good feeling I had to depend during the course of these rambles, for me to take this opportunity of testifying, what a perfect sense of security, and confidence of all needful protection, I shortly learnt to acquire, in whatever direction I thought proper to direct my footsteps through these wild and solitary districts.

No doubt there is often found in such countries, a recklessness of character—an indifference to the shedding of blood, which, if it arises in part from the difficulty of obtaining redress for injuries or affronts through the ordinary channels of justice, is at the same time fostered by the continual influx of the wilder

of the Ozark mountains, and is the first elevated land met with on proceeding westward from the

spirits from other States, who seek an asylum in regions not yet brought under the dominion of law.

But these very circumstances render it the more creditable to the older settlers of the country, to have established, by the force of opinion, throughout the wide tracts over which they are scattered, that pervading principle of honour and good faith, which not only exempts the stranger from risk to his person or his property, but guarantees to him, wherever he goes, all essential accommodations, without fear of extortion, or chance of insult.

In confirmation of these remarks, I have much satisfaction in quoting a passage from a letter, which I received a short time ago from a late distinguished member of the American bar and senate, whose warm-hearted hospitality and friendly attentions had procured for me, during a portion of my rambles, the rare privilege of surveying at my leisure an interesting and remote district, whilst in the full enjoyment of intellectual society, and of all the luxuries and comforts of civilisation.

"I think I see you," he says, "winding your way through the country between the Warm Springs of Arkansas and St. Louis. When I had health and strength, such travelling afforded me a great deal of pleasure.

"But you must have 'roughed' it, as they say here, with a vengeance, and at times felt severely the want, of what our habits make, and the world calls, comforts.

"Still there was a charm to me, in the solitude of our woods, and in the originality of character you so frequently meet with in these remote regions, which I cannot describe.

"I am glad you took the route, and I can confirm the truth of your remark, that the population of the distant settlements is greatly superior to the lower classes you meet with in our towns, and on our water-courses. The worst population of every country, I believe, is to be found on its sea-shores and navigable rivers. You may ride thousands of miles through the remotest and most thinly settled parts of a western country, with as complete a sense of security, as you would enjoy, in traversing the streets of London, under the eyes of half a dozen police officers—and the fact, which is undoubted, speaks, I think, volumes in favour of the people."

Mississippi, though its greatest height is probably not more than 500 or 600 feet above that river.

The only circumstance connected with this range of hills, which can throw any light upon the origin of the thermal waters that issue from it, is the breaking out at their foot, near New Madrid, of that tremendous earthquake, which, in 1812, caused the permanent submersion of a considerable tract of land near the Mississippi, now converted into an extensive swamp[1].

Such is the depth to which this tract has been submerged, that nothing but the summits of the trees, I am told, are seen standing above the surface of the stagnant morass.

A slightly thermal spring, which goes by the name of Mud Creek, exists in the same parallel as New Madrid, and at a distance of not many miles from the submerged tract in question.

Such are the principal particulars I have been able to bring together, either from personal observation, or from information supplied me by others, with respect to the thermal waters existing within the limits of the United States of America.

The rarity of such phenomena, when the extent of country is taken into account, as well as the unfrequent occurrence of acidulous or carbonated waters, might have been anticipated, from the unfrequency of earthquakes, the regularity of the rock formations, and the absence of trap rocks from so large a portion of the continent.

Nevertheless, the occurrence of a few such springs

[1] See Lyell's Principles of Geology, vol. I. p. 408.

in the midst of the Alleghanies, and elsewhere, seems to shew, that volcanic operations are going on, in a covert and languid manner, underneath certain parts of that range.

To these operations, acting formerly with greater intensity, may perhaps be attributed, the uplifting of the chain itself, as well as the vertical and disturbed condition of the strata round about the anticlinal line; whereas, at present, the same forces only manifest their existence, by imparting a higher temperature to a few of the springs which burst out at this point, and possibly also, by causing the emission of those volumes, of sulphuretted hydrogen, and of carbonic acid, which impregnate others within a certain distance of this axis of elevation.

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ON THE

EARLIER NOTICES

RELATIVE TO THE NATURAL HISTORY

OF

THE GIRAFFE.

READ TO THE ASHMOLEAN SOCIETY, MARCH 26, 1838.

THE extraordinary form and lofty stature of the giraffe, or camelopard, combined with the singular mixture of different groups, which its characters appear to present, have rendered it in all ages an object of attention and wonder. "In the contemplation of this animal," says Col. Hamilton Smith, in his treatise on the Ruminantia, (Griffith's translation of the Règne Animal vol. iv. p. 150.) "our imagination is involuntarily led back to the early epochs of the earth, when colossal beings peopled the earth, and were the undisputed possessors of every region: we fancy ourselves in the presence of one of the survivors of the great diluvian catastrophe, when the mastodon, the megatherium, and perhaps its own congeners, were swept away, to leave this one species, among a few others, to attest what were the forms of a primitive animated nature." From the complete isolation of this singular

animal in family, genus, and species[a], it is impossible to misapply any description intended for it, however distorted or imperfect: while at the same time its appearance, form, and colours, are too remarkable for the most cursory or superficial writer on general zoology, who was aware of its existence, to pass it without notice. Hence, from the earliest period at which it became known to civilized nations we find repeated mention of the giraffe in the works of historians and geographers, as well as of professed zoologists: and as living specimens were from time to time brought into Europe, at first for exhibition in the splendid shows and processions of the Roman emperors, and in later ages as presents from the Mohammedan princes of Africa to the European sovereigns with whom they held diplomatic intercourse, it might have been expected that tolerably accurate notions of its form and manners would have reached us from early writers. But the accounts thus transmitted are, generally speaking, so confused and contradictory, that in some instances even their application to the animal under consideration can be determined only by the ascertained non-existence of any other species[a] with which it might be confounded: so unsatisfactory, indeed, did these early notices appear, that when nearly 300 years had elapsed since a living specimen had been seen in Europe, (the last, I believe,

[a] Mr. Ogilby, in his arrangement of the Ruminantia, (Proceedings of Zoological Soc. part iv. p. 134.) says, "Duo species sunt *Camelopardalis Æthiopicus* et *C. Capensis*:" but without stating on what grounds he supposes this specific distinction to rest.

being the one sent, A. D. 1487, to Lorenzo dei Medici, by Malec-al-Ashraf Kayd-Bey, the Circassian sultan of Egypt,) some naturalists began even to entertain doubts of the separate existence of the giraffe, the statements respecting which appeared at once so vague, and so much at variance from all known forms among quadrupeds;—and the idea that it might be referred to one of the large variegated African antelopes was the more plausible, as the greater number of its early describers strangely omit all mention of its extraordinary stature, and the few who notice this point might, from the notorious propensity of zoologists of that age to crowd their pages with marvels, be not unreasonably suspected of exaggeration. The stature of those seen in Europe might also probably be less remarkable from the animals being taken young, and not surviving long in captivity: and this must certainly have been the case in the one which Prosper Alpinus saw at Alexandria in 1581, and describes as being about the size of a small horse.

From the time of Prosper Alpinus to the latter part of the last century, when all doubts were cleared up by its discovery at the Cape, a locality more accessible to Europeans than its previously known habitat of Central Africa, no European writer, except Hasselquist, appears to have seen either the giraffe or its skin; and the accounts published during that interval are consequently copied from the earlier notices. A meagre and technical account, adding little or nothing to our real knowledge of the animal, was published by Hasselquist in 1762, from a skin seen at Suez: but the skins brought to Europe from the Cape by Gordon and Patterson, and sub-

sequently by Le Vaillant, with the details of the manners, and the accurate figures, published by the latter, at once restored the giraffe to its legitimate station in the animal kingdom: and demonstrated that the accounts given of its anomalous form and structure, however caricatured and disfigured by fiction, had their origin in an existing quadruped, the actual proportions and details of which were little less extraordinary than the most marvellous statements of its former historiographers. On such of these earlier notices as appear to possess interest, either from their singularity, or from having been taken from the living animal, I shall proceed to offer some remarks; arranging my quotations in the chronological order of the authors from whom they are taken.

From the neighbourhood of Egypt to Ethiopia, we might anticipate that the giraffe would be known to the ancient Egyptians: and accordingly we find it represented in the monuments of Thebes, where the chiefs of four different nations bring tribute and presents to Thothmes III. who is supposed to have been the Pharaoh under whose reign the Israelites quitted Egypt. (Wilkinson's Ancient Egyptians, i. 54.) The figure, as copied in Wilkinson's work, is by far the most accurate and characteristic representation of the animal which existed till within a few years, shewing the gait and attitude with remarkable spirit and fidelity: the individual represented appears from the height to have been a young one, and is led by two men by lines attached to each fore-leg, while a monkey is climbing up its neck; the figures of baboons, leopards, antelopes, &c. which appear in the same procession, are equally

faithful resemblances. It nevertheless appears doubtful whether the animal was known to the Israelites: the *zemer*, זמר, mentioned in Deuteronomy xiv. 5. is rendered "camelopardalis" both in the Septuagint and Vulgate, and *zorāfa* (الزرافة), or giraffe, in the Arabic version: but Bochart (Hiero-Zoïcon, lib. iii. c. 21.) contends that the Hebrew word implies a wild goat, or some leaping animal, an interpretation adopted in our authorized version, where it is rendered *chamois:* and the probability of this is strengthened when we consider, that even if the Israelites had been acquainted with the giraffe in Egypt, it was not at any period a native of Palestine, whither they were then directing their course, and to which the animals permitted or prohibited as food would in all likelihood be indigenous.

To Aristotle, the father of scientific zoology, the giraffe seems to have been unknown: and the earliest author who gave a description of it was apparently the Sicilian Timæus, who lived about 260 years before Christ: his works, in their original language, have perished, but some fragments of them are preserved by Arabic writers: and among these is a passage quoted in the "Wonders of the Creation," (عجـايب المخلوقات), by Zakaria Ebn Mohammed Al Kazwini, to the following effect:— "Timat (Timæus) relates, that in the south, near the equator, animals of all species assemble in summer near the waters to quench the thirst which consumes them: this leads to connexions between animals of different species, and from these ill-assorted unions spring such strange animals as the giraffe, the *sima*, the *isbar*, &c. Among all these

animals, the giraffe is the most wonderful, both for the beauty of its form, and the extraordinary manner of its production. For they say that the giraffe proceeds from a female Ethiopian camel, a wild cow, and a male hyæna: for in Ethiopia, the male hyæna pairing with a female camel, she gives birth to a young one partaking of the natures of both parents: and if this happens to be a male, and to pair in its turn with a wild cow, the result of this second cross is the giraffe." It is not quite clear from the context whether the details of this strange genealogy are given by Kazwini on his own authority, or form part of the quotation from Timæus: the wild cow mentioned (in the Arabic البقرة الوحشية), is the addax antelope, (Strepsiceros of Pliny,) a large species, of the African deserts. The next author, in point of time, to Timæus, in whom I find any details relative to the giraffe, is Agatharchidas, who wrote an account of the Red sea, and the countries bordering on it, about B. C. 180. " In the region of the Troglodytes," he says, " is found the animal called by the Greeks *καμηλοπάρδαλις*, a compound term in accordance with its mixed nature. For its colour is varied like that of a panther, but its size is that of a camel: the thickness is disproportionate, and the neck so long that it can gather its food from the tops of trees." It may be remarked that Agatharchidas speaks of the animal as already known to the Greeks, and they had doubtless become acquainted with him through the conquests of the Macedonian kings of Egypt.

The earliest indication of the giraffe being known to the Romans is afforded by the famous mosaic pavement placed by Sylla in the temple of Fortune

at Prænestе, where two spotted giraffes appear together, as well as a larger animal with short horns, but without spots, and with a name written over, which has been variously read YABOUC and PAΦOYC, words supposed by Col. Hamilton Smith to bear some relation to Nabis, the name applied by Pliny to the giraffe. The explanation of this mosaic has given rise to some controversy: Father Kircher supposing it to be an allegorical representation of the vicissitudes of Fortune, while others consider that the subjects depicted illustrate the progress of Alexander the Great through Egypt to the cataracts of the Nile. But the silence of Aristotle on the giraffe is almost conclusive against its being known to Alexander. But for the direct testimony of Pliny that Julius Cæsar was the *first* who brought it to Rome, I should be inclined to suspect that the various animals portrayed were those exhibited by Sylla in the splendid shows of his ædileship; and for the importation of which from northern Africa, his friendship with the Numidian prince Bocchus gave him such facilities, that the populace (according to Sylla's own Commentaries as quoted by Plutarch) refused to elect him prætor till he had served the office of ædile, lest they might lose the sight of the African rarities which they expected him to bring forward in the latter capacity. The absence of the giraffe from these games seems to prove that then, as now, it was confined to the south of the Sahara: in this case its introduction into the Prænestine mosaic may probably be explained by supposing the artists to have been Egyptian Greeks, to whom this kind of work appears, till a much later period, to have

been confined [b], and who would naturally represent the animals known in their own country.

The magnificent triumph of Julius Cæsar over the East, on his return from his Egyptian campaign, was the first occasion on which a giraffe was seen at Rome; and the interest and astonishment excited by its singularity of form and beauty of colouring, are evidenced by the numerous notices which we find in the authors who treat of this period. Varro (*De Lingua Latina*, lib. iv.) speaks of the Camelopardalis as "the animal lately brought over from Alexandria, resembling the camel in form, and the panther in markings;"—his predilection for the party of Pompey, perhaps, restraining him from giving more than this brief notice of an animal, for the knowledge of which Europe was indebted to the rival and conqueror of his old commander.

Dio (who wrote three centuries after the time) thus describes the giraffe, (lib. xliii.) in his account of Cæsar's triumph: "This animal is in all respects like a camel, except that its limbs are not of equal proportions: for its hind-legs are much lower than the fore, and the body, from the loins forward, is raised and shortened, so that it appears as if it ascended; and the anterior part of the body, which is raised up highest, is further elevated by the great length of the fore-legs: the neck also is remarkably long. It is spotted like a panther, whence its name." No notice is here taken of its stature: and this and other descriptions are in error in attributing the elevation of the anterior part of

[b] See a note by Col. Hamilton Smith, in Griffiths' Règne Animal, iv. 154.

the body to the greater length of the fore-legs, as it results from the length of the omoplate, or shoulder-blade, and the great extension of the spinous processes of the vertebræ of the back; the hind and fore-legs being nearly of the same length.

From this time, according to Pliny, the giraffe was not unfrequently seen in Rome: the constant intercourse between Italy and the province of Egypt facilitating the transmission of the wonders of Africa to the imperial city. Strabo, writing in the reign of Augustus, gives the most detailed account of its appearance and manners which had hitherto appeared: and his description will be read with interest, as the geographer, from his extensive travels in Upper Egypt, had probably seen the animal amidst its native scenery, as well as in the confinement of a Roman menagerie. "In these countries is produced the camelopardalis, an animal not at all resembling a panther, as might be imagined: for in the variegation of its colours it more resembles a fawn, and is marked with striped hairs (*ῥαβδωτοῖς πίλοις κατεστιγμέναι*): the hind quarters are lower than the fore, seeming to settle down towards the tail, where it is not higher than an ox, whereas the fore-legs are as high as those of a camel: the neck is straight, and raised to a great height, so that to the top of the head it is much taller than a camel. From this disproportion of parts, I should not think the animal likely to possess the extraordinary swiftness attributed to it by Artemidorus, who says, that nothing can overtake it. It is not, however, a ferocious animal, but graminivorous in its habits (*οὐδὲ θηρίον ἀλλὰ βόσκημα μᾶλλον*)." He further notices, as natives of the same country, the sphinges and cynocephali, different species of baboons, which

appear in the Theban monuments in the same procession as the giraffe.

Horace indicates this animal as forming part of the customary attractions of the Circensian games[c]:

——— seu
Diversum confusa genus panthera camelo,
Sive elephas albus vulgi converteret ora.
Epist. II. 1. 195.

[a passage which may be considered as proving incidentally the former existence of an albino variety in the African elephant, the white individuals of the Asiatic species being confined to Ceylon and Birmāh; countries unknown to Europeans in the age of Horace. The African elephant is now confined to the south of that continent, and is not known to occur of a white colour in the present day: if, unlike its Asiatic congener, it bred in confinement, as some zoologists have supposed, it would doubtless vary in colour like other domesticated animals. The period at which its domestication fell into disuse does not exactly appear: it continued longest in Ethiopia. The negus of Abyssinia received the ambassadors of Justinian, A. D. 533, on a platform or chariot drawn by four elephants: and in the famous attack of Mekka by the Abyssinians, A. D. 569, their general Abrahah was mounted on a white elephant: whence the 105th chapter of the Koran, in which this incident is recorded, is entitled the "Chapter of "the Elephant." The conquest of Africa by the Saracens, at the beginning of the next century, probably hastened its final disuse; as the superiority

[c] Pausanias (lib. 9.) says, that he had seen at the Roman games Indian camels spotted like panthers, which can refer only to the giraffe.

of the Arabian camel to the elephant, in swiftness and power of abstinence, would reduce the latter to comparative inutility on the sandy deserts of Barbary.]

The account of the giraffe given by Pliny (Hist. Nat. lib. viii. c. 28.), and copied almost verbatim by his plagiarist Solinus, is singularly meagre, when we consider the length of time the animal had been known. "Nabin Æthiopes vocant, collo similem "equo, pedibus et cruribus bovi, camelo capite, albis "maculis rutilum colorem distinguentibus, unde ap- "pellata camelopardalis, dictatoris Cæsaris ludis "Circensibus primum visa Romæ. Ex eo subinde "cernitur, aspectu magis, quam feritate, conspicua: "quare etiam *ovis feræ* nomen invenit." The name Nabis is curious, as corresponding almost exactly with the Hottentot term *Naïp:* but the colours of the ground and the spots are inverted in the description, and but for the mention of the name Camelopardalis, it would have been difficult to decide the animal meant: and in this, as in all the preceding notices, no mention is made of the existence of horns, though the animal might almost be considered to have three; the frontal prominence differing in little but length from the horns, which are themselves merely prolongations of the bone of the skull, without any solution of continuity. These horns, however, are mentioned by no ancient writer up to Oppian, who introduces a very spirited description of the animal at the end of the third book of the Cynegetica:

Ἐννεπέ μοι κἀκεῖνα, πολύθροε μοῦσα λιγεῖα,
Μικτὰ φύσιν θηρῶν, διχόθεν κεκερασμένα φῦλα,
Πόρδαλιν αἰολόνωτον ὁμοῦ ξυνήν τε καμήλῳ.

Ζεῦ πάτερ, ὅσσα νοήσας, ὅσ' εἴδεα νῶϊ φύτευσας,
Ὅσσα βροτοῖσιν ὄπασσας, ὅσ' εἰναλίοις νεπόδεσσιν,
Ὅς τόδ' ἐμήσαο πάγχυ καμήλων αἰόλον εἶδος,
Ἀμφιέσας ῥινοῖσιν ἀναιδέσι πορδαλίεσσι,
Φαιδίμον, ἱμερόεν, τιθασὸν γένος ἀνθρώποισι·
Δειρὴ οἱ ταναὴ, στικτὸν δέμας, οὔατα βαιὰ,
Ψιλὸν ὕπερθε κάρη, δολιχοὶ πόδες, εὐρέα ταρσά.
Κώλων δ' οὐκ ἴσα μέτρα, πόδες δ' οὐ πάμπαν ὁμοῖοι·
Ἀλλ' οἱ πρόσθεν ἔασιν ἀρείονες, ὑστάτιοι δὲ
Πολλὸν ὀλιζότεροι, κατά τ' ὀκλάζουσιν ὁμοῖοι.
Ἐκ δὲ μέσης κεφαλῆς δίδυμον κέρας ἰθὺς ὀρούει,
Οὔτι κέρας κερόεν, παρὰ δ' οὔατα μεσσόθι κόρσης
Ἀβληχραὶ κροτάφοισιν ἐπαντέλλουσι κεραῖαι.
Ἄρκιον, ὡς ἐλάφοιο, τέρεν στόμα, λεπταλέοι τε
Ἐντὸς ἐρηρέδαται γαλακτόχροες ἀμφὶς ὀδόντες·
Αἴγλην παμφανόωσαν ἀπαστράπτουσιν ὀπωπαί·
Οὐρὴ δ' αὖτ' ἐλάχεια, θοαῖς ἅτε δορκαλίδεσσιν,
Ἄκραισιν μετόπισθε μελαινομένῃσιν ἐθείραις.

The exactness of this description, independent of its poetic merits, is in some points remarkable: particularly in the observation that the so-called horns do not consist of horny substance (*οὔτι κέρας κερόεν*): and in the allusion to the pencils of hair (*ἀβληχραὶ κεραῖαι*) with which they are tipped. That the animal must have been seen alive by Oppian, is evident from his remark on the brilliancy of the eyes, and the halting motion of the hinder limbs: and his sketch is altogether so vivid and characteristic, that it makes some amends for the obscure and imperfect notices quoted above. In his catalogue of animals he places it next to the ostrich, apparently from the idea that their common resemblance, in some points, to the camel, constituted a sort of relationship between them.

As Oppian died at the age of thirty, A. D. 213, he could scarcely have derived his knowledge of the

giraffe from the one which Dion states Commodus to have produced, A. D. 190, among the animals which he slew with his own hand in the circus, for the purpose of displaying his skill as an archer[d]. It is more probable that he drew his description from the numerous specimens imported in the early part of the third century by the Gordian family, whose vast estates in Africa enabled them to adorn the magnificent shows which they exhibited to the people, with many animals till then rare or unknown. The menagerie (*sylva*) of the eldest Gordian when quæstor was exhibited, according to Capitolinus (Hist. Aug. Script. ii. 81.) by paintings in the Domus Rostrata, a palace built by Pompey the Great, which at that time was the family mansion of the Gordians: among the rarities which it contained, and which were all abandoned to the populace on the last day of the festival, are enumerated 100 palmated stags (*cervi palmati*), probably fallow-deer, 30 wild horses, 10 elks, 30 onagri, 300 ostriches, 200 ibexes, and 100 *oves feræ*, the name by which, according to Pliny, the giraffe was popularly known. The number appears to stagger Casaubon, who suggests in a note that these *oves feræ* may have been, not giraffes, but genuine wild sheep or *mouflons*, such as exist at the present day in Corsica: but these animals were well known to the

[d] Gibbon, in a note on this passage of Dion, says, that at the time he wrote (1776), the giraffe had not been seen in Europe since the revival of letters: he calls it, in one of those antithetical sentences in which he delighted, "the tallest, the most gentle, and the most useless of the large quadrupeds:" but this last epithet is not more applicable to the giraffe than to any other of the larger Ruminantia.

ancients under the names of *musmon* and *tragelaphus*, by which Pliny describes them, and are nowhere designated *oves feræ:* and even if we suppose that an error may have crept into the number in the progress of transcription, it is not probable that the giraffe would be altogether absent from an exhibition, the principal novelties of which were evidently drawn from its native country. Nor will the number of 100, on an occasion of extraordinary splendour and solemnity, appear so remarkable, when we find that the third Gordian, grandson of Gordian the elder, kept in his private menagerie, when emperor, exclusive of the animals devoted to the public games, 10 camelopards, a hippopotamus, a rhinoceros, 20 onagri, 40 wild horses, "et cætera hujus-"modi animalia" (says Capitolinus) "innumera et "diversa"—all which were either killed or dispersed, two years after the death of Gordian, at the secular and Circensian games given to celebrate the thousandth anniversary of the foundation of Rome, by the emperor Philip the Arabian (ib. 134.).—Thirty years subsequently, only a single camelopard, if the text of Vopiscus is accurate, was seen at the triumph of Aurelian over Zenobia and the East; it was probably brought from the country of the Axumitæ or Abyssinians, who are mentioned among the fifteen conquered nations whose representatives walked in the procession, and whose name still exists in the city of Axum near Gondar.

After the removal of the capital to Constantinople, the giraffe was less frequently seen in Europe: the next notice of it in point of time which has fallen under my observation, is in the 10th book of the Greek romance by Heliodorus, called "The Ethio-

" pics: or the Loves of Theagenes and Chariclea." (This was a juvenile production of Heliodorus, who, when he afterwards became bishop of Tricca in Thessaly, was severely commented upon for having written it: and the Ecclesiastical History of Nicephorus even asserts, that the provincial synod having given him the option of either burning his novel or resigning his see, he preferred the latter course: but this is contradicted by other writers, and does not appear probable.) In the passage above referred to, he introduces the ambassadors of the Axiomitæ as bringing gifts to Hydaspes king of Ethiopia, " and among them an animal of a strange and wonderful form, in bulk about equal to a camel, and having the skin mottled with florid spots like scales: the hinder parts from the stomach were low like a lion, but the shoulder-blades, fore-feet, and breast, were raised out of all proportion to the other parts: the neck slender, and lengthened out like that of a swan: the head resembling that of a camel's in form, and rather more than twice as large as that of a Libyan ostrich: its eyes appeared as if painted[e], and it rolled them strangely. It waddled in a way unlike the pace of any other animal, terrestrial or aquatic: moving its legs not alternately, but those on the right both together, and then those on the left in the same manner: it was so tame and gentle that the keeper led it by a small string from the

e " Ὀφθαλμοὺς ὑπογεγραμμένους." This phrase is erroneously rendered, in the quotation in Griffith's Cuvier, " eyes which had a film over them :" but ὑπογραφὴ ὀφθαλμῶν implies the colouring of the edges of the eyelids with surmāh, as practised by women in the East; and whoever has seen the full dark eye of the giraffe, must admit the justness of the comparison.

head, as easily as by a strong chain. Its appearance struck the whole multitude with astonishment, and they gave it extempore the name of Camelopardalis." The statement of its moving the two legs on the same side at once, proves that Heliodorus must have seen the animal, which might otherwise have been doubted from his saying that the head was only twice the size of that of an ostrich: unless, as old Le Vaillant quaintly remarks on the passage, the relative proportions of the two animals have undergone a great change since that time.

Heliodorus lived at the end of the fourth century, and I have not found any mention of the giraffe being seen in Europe for several hundred years after this time: and the conquest of Egypt and Africa by the Arabs, early in the seventh century, intercepted the communication of the Greeks of the Lower Empire with the countries in which it is found: it appears to have been early known to the Arabs (whose doctors state doubts whether it was permitted for food by the Mohammedan law[f]), by the name of zorafa or zorafat (زرافة), a name derived by Bochart from zarfa (زرف), "to walk with a long stride[g]:" a name of which the ζοραφὶς of the Byzantine Greeks, and the *giraffe* of the Franks, are obviously corruptions.—The Persians, who had never seen it till the union of Asia and Africa, under the sway of the caliphs, introduced Egyptian rarities at the court of Bagdad, designated it in their own language by the compound term اشتر گاو پلنگ or

[f] Bochart.

[g] The same author suggests that Nabis may be derived from the Arabic *naba* نبا, to be raised or exalted.

camel-cow-tiger[h], from the resemblance they perceived in it to all those animals. Various Arabic writers quoted by Bochart, have mentioned or described it: but their accounts contain little to interest, and are generally disfigured by fable. The story of its triple generation by a male hyæna, a female camel, and a wild cow or antelope, is repeated by Ebn Khalcan and other authors besides Kazwini; the hint for this strange fiction seems to have been given by a remark of Aristotle, that the monsters reported to occur in Africa might probably originate from the meeting of different animals at the waters in the deserts: this was applied by Timæus, as quoted above, to the giraffe, and improved upon by the fertile fancy of the Arabs: Aljahed alone restores it to its legitimate rank as a species, and asserts that it was propagated by its kind in the ordinary course of nature.—Its appearance is thus described by Kazwini:—"Its head resembles that of a camel: it has the horns and hoofs of an ox, the skin of a panther (نمر), and the legs of a camel: its neck is of disproportionate length; its fore-legs are high, and its hind ones low: its general form most resembles that of the camel, and its skin that of the tiger (ببر): its tail is like that of the antelope." The small size of the tail, according to Bochart, is alluded to in the name given to the animal in the Amharic dialect of the Abyssinian tongue, *zirath-katchin:* which, as he was informed by Ludolfi, implies λεπτοκέρκος, or slender tailed. Kemaleddin Al-Damiri states, that it has no joints in the hind-legs, as Cæsar had previously asserted of the elk: this error probably originated in their shuffling

[h] Alkami.

gait: but Kemaleddin's History of Animals is so replete with errors, that Ahmed Al Afcasbi wrote a work expressly for their correction, though I am not aware whether he noticed this among the rest[i]. Kemaleddin, however, gives an accurate account of the manner in which it browses on the branches of trees, and ascribes the greater height of its anterior extremities to a provision of Providence for the purpose.—I am informed by the keeper of the Ashmolean Museum, that an Arabic MS. of the travels of Ebn Batuta, in one of the Cambridge libraries, contains an illuminated figure of the giraffe: but I have not succeeded, on a cursory examination, in finding any notice of the animal in Professor Lee's translation of the abridgment of that work[k]. It is needless to give any further extracts from the Oriental accounts: their general value may be estimated from the specimens given above: in the case of less known or fabulous animals, many Oriental naturalists gravely admit fictions as strange as the wildest hearsay narrations of Ctesias or Herodotus.

The notice of the giraffe by the Greek annalist, Michael Glycas, under the reign of Alexius Comnenus, proves that its existence was then only remembered in Europe by the statements of former writers: he relates that it is said (ἱστόρηται) to occur in Libya, and repeats the old fable of its hybrid origin, though with a diminution of the number of its parents to two. It is not improbable that on the renewed intercourse between the Greek empire and

[i] D'Herbelot in art. Demiri, p. 290.

[k] Edrisi, the Nubian geographer, enumerates it among the animals found only in the first climate, or torrid zone.

Egypt during the crusades, it may occasionally have been brought to Constantinople: but the only instance of which I have chanced to detect any record in the long and dreary series of the Byzantine historians, was A. D. 1260, when an embassy was sent by Rokneddin Bibars, the fourth Mamluke sultan of Egypt, to the emperor Michael Palæologus, in order to obtain permission for Egyptian vessels to pass the Bosphorus and Dardanelles, with cargoes of Tartar slaves from the Crimea to reinforce the ranks of the Mamluke corps. Among the presents which accompanied this mission was a giraffe, which the Byzantine historian, George Pachymeres, (who vehemently condemns the emperor for thus augmenting the strength of the infidels,) describes with a minuteness shewing how rare such a spectacle then was in Europe. "Concerning the camelopard sent over on this occasion I shall make a few remarks, for the information of those who saw it not, and to refresh the recollection of those who did. Its body was of a moderate bulk, about the size of such asses as we call Κανθῶνες: its skin, like that of a panther, white, and marked with ruddy spots. In the shape of the body it resembled a camel, but rose from the flanks towards the shoulders, so that the fore legs greatly exceeded the hind ones. The neck was very long, like that of a crane, and raised up so as to give the animal an appearance of pride. The head small, and in form like that of a camel. The belly white; and from the neck all along the spine to the tail extends a regular black list, as if drawn by a rule: the limbs are slender, like those of a deer, and with cloven hoofs. It is a tame and gentle creature,

easily led by a string from the head: it feeds on grass, but will eat bread and barley from the hand like a sheep: it is not easily provoked, but if offended or attacked (since nature has provided almost every animal with some weapon for self-defence), it defends itself, not with its heels as the horse, nor with horns as the ox, for with horns it is not provided (ἐστερηται), nor with tusks like the boar, nor yet with claws like the feline tribe; but only by biting gently with its teeth, so that its intent appears not to injure others, but merely to defend itself: for its teeth are not furnished, like those of many others, with poisonous matter to be instilled through the bite. Such, and so strange, was the appearance of the animal now sent out of Ethiopia to the emperor, who for some time caused it to be daily led about the streets and squares of Constantinople as a sight for the people, in order that, by seeing the wonderful products of this distant commerce, they might be reconciled to the alliance now concluded with the Ethiopians."—The errors, however, observable in this description would seem to indicate that while writing, as he says, to refresh the memory of others, the historian had somewhat overrated the accuracy of his own. Not contented, like the classical writers, with omitting to mention the horns, he expressly denies their existence: and in stating that the animal uses its teeth as a means of defence, he contradicts the statement of every traveller who has observed it in its native state. All agree that when surrounded and unable to escape, it endeavours to secure its head from attack by keeping its lofty neck perpendicularly elevated, while it defends itself by kicking with great force and ra-

pidity. M. Le Vaillant was told by the Hottentots that it would in this manner beat off a lion, though the panther overpowered it by leaping on its back. And M. Thibaut, who brought over the specimens now in the Regent's Park, told me that the kicks were so rapid that his eye could scarcely follow the motion of the limbs. It is not improbable that Pachymeres, writing at the distance of some years, and not thinking it likely that his account would ever be contradicted by the importation of another specimen, supplied from his imagination the deficiency of his memory; a method of theorizing which has been adopted, to the great detriment of science, by many more modern zoologists.

The specimen described as above by Pachymeres, was apparently the last ever seen at Constantinople previous to the Turkish conquest; and with the exception of two specimens sent over in the 15th century by the sultan of Egypt, one to the emperor Frederick III, the other to Lorenzo dei Medici, I can find no mention of its having been seen alive in Europe from that time till its recent introduction in the menageries of France and England. The one sent to the emperor is noticed by contemporary writers under the names of *orasius* and *oraflus*, apparently corruptions of *girafa;* and appears to have been adult, as the accounts quoted by Gesner state it to have been 20 cubits in height. By Albertus Magnus it is called *anabula*, probably a corruption of the word *nabis*, the name used by Pliny. That sent to Lorenzo dei Medici is described in a long letter from Antonius Constantius to Galeotto Manfredi, prince of Faenza, an abstract of which is given at some length by Bochart: but the only novelty it contains

is the correction of the error of Strabo in supposing the animal deficient in velocity. The writer states that he saw the animal, when exhibited at Fano, where it landed, distance horsemen at full gallop without any apparent exertion. The letter concludes with an epigram, in which the animal is represented as complaining of the omission of its horns in former accounts :

" Albertus, Magni clarus cognomine, plenam
Non didicit nostri corporis effigiem :
Non qui orbis modico scripsit memoranda libello
Plinius, et pulchræ conditor historiæ.
Non qui scriptorem dum corrigit Artemidorum
Strabo mihi dotes invidet ipse meas.
Qualiacunque vides isti mihi cornua demunt :
Laurenti, hos tibi do barbara discipulos."

This specimen is said to have been eleven feet high.

But though the giraffe was no longer seen in Europe after this period, we find frequent notices of it by such Europeans as business or pilgrimage led to the courts of Oriental sovereigns, to whom it seems to have been considered an acceptable gift, and consequently to have frequently accompanied embassies from the Egyptian sultans, of whose dominions it was a native. Marco Polo, though he does not expressly mention having seen the animal, was well acquainted with its nature, and enumerates it among the productions of Abascia (Abyssinia), and the island of Magastar, or Madagascar, in which latter locality I believe it is not now known to exist. He says, " it is a handsome beast, well proportioned, with the fore-legs long and high, the hind ones shorter, and the neck very long, measuring three paces in length, including the head, which is small

and elegant. It is light coloured, with round rufous spots, and its manners are gentle." Clavijo, who was sent in 1403, by Henry III of Castile, to the court of Timur at Samarkand (and who was the last European recorded to have visited that city), states, that on the frontiers of Armenia he met an ambassador from the sultan of Babylon (as the Frank writers of that age invariably term the Egyptian monarch), also on his way with presents to Timur, and among these was a beast whose appearance struck the whole company with astonishment. In its body it resembled a horse, and its head was like that of a stag; but its most wonderful features were the length and slenderness of its fore legs and neck, each of which measured near 16 palms, so that when it raised its head it was a wonder to be seen. It could thus reach the top of a high wall, and browse without difficulty on the leaves of lofty trees. He calls it *jornufa*, an evident corruption of the Arabic name.

Barbaro, a Venetian envoy, mentions having seen a *zirnafa* in 1475 at Tabreez, belonging to the king Uzun Hassan, or Hassan the Tall (the Ussuncassanes of Knolles and other writers of that time), who had probably received it from his Egyptian ally, the sultan Kayd-Bey, the same who twelve years later sent the one already noticed to Lorenzo dei Medici. The embassies to which these animals were accompaniments, were in all probability relative to the league formed about that period between Persia, Egypt, Venice, and the Knights of Rhodes, against the preponderating power of the Porte.

The accounts of the giraffe in the works of Aldrovandus and Conrad Gesner, in the beginning of

the 16th century, are merely repetitions of what had previously appeared. Gesner has collated these statements with great diligence, and has given a wretched figure of it, copied from a description of Palestine by an author whom he does not name, but quotes as saying, that the colours are disposed as if a fishing net were thrown over the animal, which he compares in figure to a goat; and with some likeness to a goat he accordingly represents it, with slender horns of some length curving backwards, and bearing scarcely any recognisable likeness to the animal intended. Such figures, however, in Gesner's work as are taken from the animals themselves, are very creditable, both in accuracy and execution, for the period at which they were done. Petrus Gyllius (Pierre de Gilles) in his Latin paraphrase of Ælian, which he dedicated in 1535 to Francis I. of France, inserts an account of the camelopardalis, principally taken from Heliodorus, and sufficiently proving that he never could have seen one.

Bellonius, in his Travels, lib. ii. ch. 49, describes the giraffe from a specimen which he saw at Cairo in 1555, and gives a rude woodcut, sufficiently accurate to give some idea of its appearance. His account contains several particulars previously unnoticed, as the hairy tips of its horns, its long and black tongue, and the want of *molars* in the upper jaw; though this is evidently a slip of the pen or the press for incisors, of which the giraffe, in common with all the ruminantia, except the camelidæ, is destitute in that jaw. He also notices its throwing out its fore feet together, not alternately, in running, and its inability to graze without straddling widely with

the fore legs; whence he correctly infers that in its native country its food consists of leaves of trees, "for gathering which its long neck adapts it, as it can thus reach with its head to the length of a half lance, or German pike." The notice already referred to by Prosper Alpinus, from one which he saw exhibited in 1581 at Alexandria, in company with a young elephant, is only remarkable for the small size which he attributes to the specimens, not exceeding that of a small horse; and for the mention which he makes of the frontal prominence, omitted by all previous writers. "Duo cornicula habebat, et circa frontem habebat etiam quandam eminentiam duram, carnosam, instar parvi cornu."

The Portuguese, in the extensive commerce they carried on along the Abyssinian coast, and the embassies they dispatched into the interior in quest of Ogané or Prester John, must doubtless have seen or heard of the giraffe; but I can find no further record of the fact than a letter quoted in Purchas's Pilgrims from Fernandez, one of the Jesuits, who unsuccessfully attempted to establish themselves in the country about 1610, where he enumerates, among the wild beasts of Abascia, or Abyssinia, "one so huge that a man sitting on horseback may pass upright under his belly. His shape is like a camel, but his nature diverse, feeding on leaves, which he reached from the tops of trees with his neck stretched forth."

From this time, for more than 150 years, I can find no author who has given a description of the living animal, or even of its skin: and so little, in the general absence of figures on which any dependence might be placed, was its real nature understood,

that Bochart (whose work has been so often quoted), in 1663, concluded that the omission of all mention of the horns in classical writers might proceed from their specimens having been females; a conjecture which could only have been hazarded from utter ignorance of the real nature of the giraffe's horns[1]. Linnæus, in the early edition of the Systema Naturæ, placed it doubtfully among the deer as *Cervus camelopardalis;* though he afterwards made it a distinct genus. Hasselquist, in 1762, gave an account of it from a skin which he saw at Suez; but this account, though minute as to the length of the horns, breadth of the hoofs, and similar particulars, gave no information as to the general figure, habits, and manners of the animal. This deficiency was in some degree supplied by the discovery of the animal a few years subsequently at the Cape; and the skins brought to Europe by Patterson and Gordon, enabled Buffon and Vosmaer to figure and describe it with tolerable accuracy. But it is to the indefatigable zeal of Le Vaillant that we are indebted for finally clearing away the errors with which these accounts were still disfigured. His animated account of the chace and capture of his first specimen cannot be perused without interest by any lover of nature; and the ample details which he has furnished in his Travels, not only on the form, but on the economy, food, and habits of the giraffe, are so

[1] The following notice in Edmonson's Heraldry is amusing from its naïveté: "Camelopard; said by heraldic authors to be a beast engendered between a camel and a leopard; but whoever chooses to read Dr. Goldsmith's History of the Earth, and other writers of Natural History, will find the *Camelopard* to be a distinct species of beast."

exact and complete, as to leave nothing to be supplied by succeeding observers.

From the date of Le Vaillant's travels, the spoils of the giraffe were not unfrequently imported from Southern Africa to adorn the museums of Europe; but the living animal continued for many years to be a desideratum in our menageries. Its peculiar unfitness, both from its great height and the delicacy of its constitution, for a long sea-voyage, precluded the hope of importing it from the Cape: and its existence in Abyssinia seems, in the long cessation of intercourse with that country, to have been either overlooked or forgotten. About 1821, however, the attention of naturalists was excited by a report that *wild camels*[m] had been seen in the mountains of Kordofan by some officers of the Turkish force, dispatched by the present pasha of Egypt under his son Ismail, to expel the fugitive Mamlukes from Dongola and Sennaar: these proved on further investigation to be giraffes, and three specimens, captured in Kordofan, were severally presented by the pasha, in 1827, to the emperor of Austria, and the kings of France and England. The interest excited by the arrival of these giraffes, (the first seen alive in Europe for 340 years,) must be fresh in the remembrance of every one: but unfortunately the French specimen was the only one which survived the fatigues of transport more than a few months. This loss, however, has been since supplied by the acquisition of the beautiful specimens now in the Regent's Park: and the ease with which they appear to bear

[m] Neither the Arabian nor the Bactrian camel is known to have existed in a wild state at any period within the reach of records.

our climate gives every reason to hope that this beautiful and interesting animal may reproduce here, and become a permanent ornament to our menageries. I shall conclude with an extract from the notice relative to these last, forwarded by their captor M. Thibaut to the Zoological Society in Feb. 1836.

" Instructed by Colonel Campbell, His Majesty's Consul General in the Levant, and desirous of rendering available for the purposes of the Zoological Society the knowledge which I had acquired by twelve years' experience in travelling in the interior of Africa, I quitted Cairo on the 15th of April, 1834. After sailing up the Nile as far as Wadi Halfa (the second cataract), I took camels, and proceeded to Debbat, a province of Dongolah ; whence, on the 14th of July, I started for the desert of Kordofan.

" Being perfectly acquainted with the locality, and on friendly terms with the Arabs of the country, I attached them to me still more by the desire of profit. All were desirous of accompanying me in my pursuit of the giraffes, which, up to that time, they had hunted solely for the sake of the flesh, which they eat, and of the skin, from which they made bucklers and sandals. I availed myself of the emulation which prevailed among the Arabs, and as the season was far advanced and favourable, I proceeded immediately to the south-west of Kordofan.

" It was on the 15th of August that I saw the first two giraffes. A rapid chase, on horses accustomed to the fatigues of the desert, put us in possession, at the end of three hours, of the largest

of the two; the mother of one of those now in my charge. Unable to take her alive, the Arabs killed her with blows of the sabre, and cutting her to pieces, carried the meat to the head-quarters which we had established in a wooded situation; an arrangement necessary for our own comforts and to secure pasturage for the camels of both sexes which we had brought with us in aid of the object of our chase. We deferred until the morrow the pursuit of the young giraffe, which my companions assured me they would have no difficulty in again discovering. The Arabs are very fond of the flesh of this animal. I partook of their repast. The live embers were quickly covered with slices of the meat, which I found to be excellent eating.

" On the following day, the 16th of August, the Arabs started at day-break in search of the young one, of which we had lost sight not far from our camp. The sandy nature of the soil of the desert is well adapted to afford indications to a hunter, and in a very short time we were on the track of the animal which was the object of our pursuit. We followed the traces with rapidity and in silence, cautious to avoid alarming the creature while it was yet at a distance from us. Unwearied myself, and anxious to act in the same manner as the Arabs, I followed them impatiently, and at nine o'clock in the morning I had the happiness to find myself in possession of the giraffe. A premium was given to the hunter whose horse had first come up with the animal, and this reward is the more merited as the laborious chase is pursued in the midst of brambles and of thorny trees.

" Possessed of this giraffe, it was necessary to

rest for three or four days, in order to render it sufficiently tame. During this period an Arab constantly holds it at the end of a long cord. By degrees it becomes accustomed to the presence of man, and takes a little nourishment. To furnish milk for it I had brought with me female camels. It became gradually reconciled to its condition, and was soon willing to follow, in short stages, the route of our caravan.

" This first giraffe, captured at four days' journey to the south-west of Kordofan, will enable us to form some judgment as to its probable age at present; as I have observed its growth and its mode of life. When it first came into my hands, it was necessary to insert a finger into its mouth in order to deceive it into a belief that the nipple of its dam was there: then it sucked freely. According to the opinion of the Arabs, and to the length of time that I have had it, this first giraffe cannot, at the utmost, be more than nineteen months old. Since I have had it, its size has fully doubled.

" The first run of the giraffe is exceedingly rapid. The swiftest horse, if unaccustomed to the desert, could not come up with it unless with extreme difficulty. The Arabs accustom their coursers to hunger and to fatigue; milk generally serves them for food, and gives them power to continue their exertions during a very long run. If the giraffe reaches a mountain, it passes the heights with rapidity; its feet, which are like those of a goat, endow it with the dexterity of that animal; it bounds over ravines with incredible power; horses cannot, in such situations, compete with it.

" The giraffe is fond of a wooded country. The

leaves of trees are its principal food. Its conformation allows of its reaching their tops. The one of which I have previously spoken, as having been killed by the Arabs, measured 21 French feet in height from the ears to the hoofs. Green herbs are also very agreeable to this animal; but its structure does not admit of its feeding on them in the same manner as our domestic animals, such as the ox and the horse. It is obliged to straddle widely; its two fore-feet are gradually stretched widely apart from each other, and its neck being then bent into a semicircular form, the animal is thus enabled to collect the grass. But on the instant that any noise interrupts its repast, the animal raises itself with rapidity, and has recourse to immediate flight.

" The giraffe eats with great delicacy, and takes its food leaf by leaf, collecting them from the trees by means of its long tongue. It rejects the thorns, and in this respect differs from the camel. As the grass on which it is now fed is cut for it, it takes the upper part only, and chews it until it perceives that the stem is too coarse for it. Great care is required for its preservation, and especially great cleanliness.

" It is extremely fond of society, and is very sensible. I have observed one of them shed tears when it no longer saw its companions, or the persons who were in the habit of attending to it.

" I was so fortunate as to collect five individuals at Kordofan; but the cold weather of December, 1834, killed four of them in the desert on the route to Dongolah, my point of departure for Bebbah. Only one was preserved; this was the first specimen that I obtained, and the one of which I have

already spoken. After twenty-two days in the desert, I reached Dongolah on the 6th of January, 1835.

"Unwilling to return to Cairo without being really useful to the Society, and being actually at Dongolah, I determined on resuming the pursuit of giraffes. I remained for three months in the desert, crossing it in all directions. Arabs in whom I could confide accompanied me, and our course was through districts destitute of everything. We had to dread the Arabs of Darfour, of which country I saw the first mountain. We were successful in our researches. I obtained three giraffes, smaller than the one I already possessed. Experience suggested to me the means of preserving them."

OBSERVATIONS

ON THE

NATURAL HISTORY

OF

TWO SPECIES OF WASPS.

BY

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ON

THE NATURAL HISTORY OF TWO SPECIES OF WASPS.

READ TO THE ASHMOLEAN SOCIETY, FEB. 27, 1835.

THE following remarks upon the natural history of two species of wasps, both of which are common in Great Britain, are offered to the notice of the Ashmolean Society, in the hope that they may tend to reconcile the contradictions observable in the works of all the authors who have written on the subject, from the times of Swammerdam and Ray, to the present period. Very few original observations appear to have been made since Reaumur and De Geer turned their attention to the habits of these insects; and the accounts of later writers seem nearly all taken, and frequently without acknowledgment, from the works of those illustrious naturalists. It may indeed seem presumptuous in me to differ from such men; but it is perhaps better to state the points of disagreement at once, in order that the results of my own observations, made during the summers of 1833 and 1834, may furnish additional data for any members of the Society who may feel inclined to follow up the subject, and thus either verify or refute them.

The two species which are the subject of this paper, are the Vespa Vulgaris, or ground wasp, and the Vespa Britannica, or tree wasp. The former is common in all parts of the island; the

latter, though occasionally met with in the southern counties of England, seems principally to abound in the northern districts, and in Scotland. It is by no means peculiar to Britain, as the name would seem to imply, but is spread over all the northern parts of Europe in great abundance. Some confusion has arisen with regard to the Vespa Vulgaris, whose habits are so ably described by Reaumur, in the sixth volume of his History of Insects. The species named Vespa Vulgaris by Linnæus, is in fact the Vespa Britannica, and is described by him, and by De Geer, as fixing its nest to beams in sheds, or under the eaves of houses, or to low trees; but the French entomologists afterwards bestowed the specific name Vulgaris upon that wasp which was most abundant in their own country, and in the southern parts of Europe, and whose nest is always formed in the ground. The error seems to have hitherto passed unnoticed, except that Shaw remarks that some confusion seems to prevail on the subject. The species now called Vespa Vulgaris, seems to be the Vespa Gallica of Linnæus; but as he does not mention the situation of the nest, it is not quite certain. He merely says, "Habitat in Europa Australiori[a]." Fabricius describes it as "Vespa Gallica, affinis Vulgari, at minor[b]." Mr. Wood, in his "Linnæan Genera of Insects," has figured the Vespa Britannica under the name of Vespa Vulgaris of Linnæus, and so far he is correct. But he describes the species as living in the ground, which is not the case with the Vespa Vulgaris of Linnæus. Leach seems to have been the first who

[a] Linn. Syst. Nat. vol. ii. p. 949.

[b] Fabricius, Genera Insectorum, vol. i. p. 460, ed. 1781.

gave the specific name Vespa Britannica to the tree wasp; but its habits and economy had already been fully described by De Geer[c].

The points of difference between the two species are as follow:

1. The tree wasp (Vespa Britannica) has a reddish brown spot near the point of insertion of the wings. It is seldom visible in dried specimens.

2. In the males and neuters, the base of the antennæ is yellow on the outer side, instead of being entirely black, as in the ground wasp; but the females often present exceptions to this distinction.

3. The tree wasp has two yellow spots on the back part of the corselet, whilst the ground wasp has from four to six.

4. The spots on the abdomen of the tree wasp are not so much detached from the black bands as in the other species, and, I think, less so in the males than the females. The markings on the abdomen, however, vary so much in different individuals that they cannot be safely relied on as a criterion of species. Linnæus drew a distinction between the hornets (Vespa Crabro) and the true wasps, founded on these marks, but it certainly cannot be considered as decisive; and the varieties enumerated by different authors, and particularly by Geoffroy, shew that the attention paid to this point has tended to create confusion rather than lessen the difficulty. Wasps taken from the same nest often present considerable variations in the marks on the abdomen, and no judgment can be formed from specimens in cabinets, which undergo great changes in drying.

5. Independently of the markings just mentioned,

[c] Vol. ii. p. 766 et seq. pl. 26.

the tree wasp has more black upon the body generally, than the other species.

6. The tree wasp is rather larger.

7. The organs of generation in the males of the two species, as shewn by the plates in Reaumur and De Geer, vary considerably.

8. The abdomen in each species contains the same number of rings, viz. six in the females and neuters, and seven in the males.

As the object of this paper is not to give a detailed account of the economy of wasps, which would occupy a volume, but merely to mention some statements of various authors respecting them, which have not been borne out by my own observations, I shall only give a slight outline of their habits, in order to make the details more intelligible. The interior arrangement of the nests of both species is so nearly alike, that one description will serve for both.

It can be hardly necessary to state that societies of wasps, as of bees, consist of three different classes of inhabitants, viz. males, females, and neuters. The females, which are much larger than the others, are familiarly known to every body as the large breeding wasps which appear in the spring. The neuters, or imperfectly developed females, are the ordinary wasps which infest our houses and gardens, and form the bulk of the colony. The males, not differing much from these in size or general appearance, are yet easily recognised by the practised observer, from the greater length of their antennæ, and their longer and more slender form: besides which, as is the case with the males in all this class of insects, they have no sting.

Early in the spring the female wasps, which alone

survive the winter, and which have been impregnated in the preceding autumn, seek out a suitable situation for their nests, and proceed to form a few cells in which they deposit the eggs of *neuters only*. These eggs are often laid when the cell is in an unfinished state, in order that they may be hatched as early as possible, and proceed to assist the foundress of the nest in her labours. Two or more females never unite in forming a colony, but each nest is the work of a single individual.

The author of the Insect Miscellanies (p. 307) states, that "the female wasp, instead of producing "at her first laying the eggs of workers only, depo- "sits those of *males* and *females;* but the latter, "when hatched and come to maturity, are only the "sixth part of the size of their mother, and only "lay the eggs of males." This statement seems to have been founded on some remarks of M. Perrot, a friend of Hubers [d], who supposed that there were two sorts of female wasps, the smaller of which were not larger than neuters, and which only laid the eggs of males; but he did not succeed in establishing this fact, which is entirely opposed to my own observation, as well as that of other persons who have practically attended to the subject. I have never found the eggs of males or females, early in the year, in any nest; and all the female wasps I have ever examined have been nearly as large as the foundress of the colony. Since the end of their creation is the reproduction of the species, and as the females do not lay eggs the same year that they are hatched, (according to most authors,) or take any part in the labours of the colony, they

[d] Vide Kirby and Spence, vol. ii. p. 108.

are *a priori* less likely to be hatched early in the year than the neuters, who are constantly employed in building and enlarging the nest, and in feeding the larvæ during the breeding season, and whose number far exceeds that of both the males and females put together; and it appears from observation, that the actual state of the case agrees with what we should have been led to expect.

The tree wasp frequently attaches its nest to a beam in a shed, or under the eaves of a house; but generally speaking it is found suspended from the branch of a young tree, or in a thorn hedge, and without much apparent pains being taken to conceal it. I have more than once seen a nest hanging over a walk in a young plantation, so that it could not escape the observation of any one passing that way; and one of the specimens now in the Museum was placed so near a gate leading into a wood, that it was hardly possible to go through it without disturbing the inmates. I have more often seen them attached to larch trees than to any other; but they are also found in the Scotch fir, the elm, and the beech, and still more frequently in gooseberry bushes in gardens, where they are likely to find abundance of food[e]. Professor Rennie, in the Insect Architecture, (p. 82,) observes, that "the tree which the "Britannic wasp prefers, is the silver fir, whose "broad flat branch serves as a protection both from "the sun and the rain." I have seen some hundreds of nests in young plantations, which abounded with silver firs, but I hardly ever saw a single in-

[e] One of the specimens in the Museum has three holes in the top of it, in which large red gooseberries were growing at the time it was taken.

stance of their being suspended from that species of pine. The larch, which they seem to prefer, affords less protection than almost any other tree; but from the nature of the materials of which the nest is composed, they are nearly independent of shelter either from heat or wet.

It was not till Reaumur had devoted many years to the study of insects, that he succeeded in discovering the nature of the materials employed by wasps in forming their habitations. It is unnecessary to repeat his interesting account, as it has been copied into almost every subsequent work on the subject[f]. He asserts that the wood which they prefer for that purpose is such as has been long exposed to the weather, and is old and dry. White[g], of Selborne, and Kirby and Spence[h], on the contrary, maintain that they make use of sound timber only. I have often observed wasps in the act of collecting materials from fir wood, but not from any other species, and this was never in a state of advanced decay, but nearly in the condition described by Reaumur. The paper of which the ground wasp forms its nest is more friable than that used by the other species, and some nests are of a much more yellow tint than others, and in fact resemble as nearly as possible the colour of rotten wood. It seems probable therefore that the ground wasp employs wood in various states of decay, but I believe the Vespa Britannica only uses wood nearly sound, on account of the greater degree of toughness requisite in a nest that is to resist the action of the weather. In such cases it gnaws the softer parts

[f] Reaumur, vol. vi. p. 182. [g] White's Selborne, vol. ii. p. 228.
[h] Kirby and Spence, vol. i. p. 508.

away, leaving the streaks or fibres standing up above the rest of the surface, being perhaps too hard to answer its purpose.

Mr. Wood, in the work before quoted, says, "The "*males* are employed to collect the wood from the "frames of windows, and from old posts and rails." If by this he means that the males are employed *exclusively* in collecting materials, (and he does not mention that the neuters give them any assistance,) the statement cannot possibly be correct, and I much doubt whether they ever join the others at all in that part of the labours of the colony. They are certainly not produced early in the season, when the first neuters are hatched; and at all events their numbers are so small compared with the neuters, that they would be quite incapable of collecting sufficient wood for constructing a nest of ordinary dimensions. I believe that their chief occupation consists in cleaning and preparing the cells for successive broods, though they may perhaps occasionally assist the neuters in building and gathering materials; but the chief portion of the work is performed by the latter; and we accordingly find, that they are the first that die in the autumn, when there is no longer any necessity for their assistance. Kirby and Spence (vol. ii. p. 110.) likewise deny that the males assist in building or in feeding the young, but consider them as the "scavengers of the com-"munity, for they sweep the passages and streets, "and carry away all the filth."

The exterior covering of the nest of the Vespa Britannica, when completed, is composed of from ten to sixteen layers of the paper-like substance before mentioned, disposed one over the other, in such

a manner that each sheet barely touches the next, instead of being placed so as to form a solid mass. In this state, a nest is capable of resisting the heaviest rains. In both species the layers of cells in which the grubs are deposited are formed of the same materials as the outside, and are always placed with the opening of the cells downwards, differing in this respect from those of the bee, in which the cells are always in a horizontal position. Both species too commence their work from the top, and build downwards.

The nest of the tree wasp in its earliest state does not exceed an inch in diameter, and contains five or six cells only. It is formed of two semicircular layers of the paper, the upper one projecting a little over the other, so as to shoot off the rain. A hole is left at the bottom of it just large enough to admit the female wasp. As soon as the first workers quit their cells, they begin the task of enlarging the nest, and of adding fresh layers of cells in which the female immediately deposits more eggs. The nest however in all its stages has the appearance of being in a *finished state* externally, and it is probably this fact which has given rise to a great many mistakes in authors, who from finding nests varying in size from one to twelve inches in diameter, have been led to describe them as the productions of distinct species of wasps, whilst they were in reality the work of the Vespa Britannica alone. It sometimes of course happens, that when the nest is in its earliest state, the female wasp is accidentally destroyed when absent from it. In this case the neuters forsake their habitation, and by some curious instinct the young wasps which emerge from their

cells after the others have left it, immediately follow their example[i]. Specimens of such deserted nests are occasionally found in the later months; and this has contributed to keep alive the error that they were the work of some rare species, to which the names of Vespa Campanaria, from the bell shape of the early nests, and Vespa Holsatica have been given.

Ray mentions "a species of Vespa, which attaches "its nest to the beam of a building, three inches in "diameter." This I have no doubt was the nest of the Vespa Britannica, and was probably found about May, when they usually attain that size.

Reaumur figures a nest[k] which he says contained two layers of cells, and bore a considerable resemblance in size and shape to a half expanded Provence rose, and Kirby and Spence[l] mention a nest, which they consider to be of the same species, except that it contained only one layer of cells, as occurring in a garden at East Dale. It is called la Guêpe de Holstein, (Vespa Holsatica,) by Latreille[m]; but the descriptions given by these various authors agree precisely with that of the Vespa Britannica, to which species it must be referred. I am further confirmed in this opinion, from the fact that Reaumur's nest contained two layers of cells, and Kirby and Spence's only one. This shews, that however perfect the nest might appear externally, it was still in a state of progression, and that in both cases, had they been allowed to continue undisturbed, several more layers would have been added to each.

[i] Reaumur, vol. vi.

[k] Reaumur, vol. vi. pl. 19. fig. 1, 2. The above figure is copied in Insect Arch. p. 82.

[l] Kirby and Spence, vol. i. p. 510.

[m] Annales du Museum d'Hist. Nat. i. 289.

Mr. Knapp, in his very entertaining work, the Journal of a Naturalist, (p. 333, 2d edit.) mentions that he had seen the nest of another rare British species of wasp, which he calls Vespa Campanaria. It is fortunately figured in his work, and I venture to give the same explanation of it as of the others. Indeed, on comparing a small nest of the Vespa Britannica with his engraving, the similarity is such, that a doubt can hardly exist upon the subject [n].

It seems that Mr. Knapp considers the Vespa Campanaria here spoken of, to be a distinct species from the Vespa Holsatica. Shaw, in the Naturalist's Miscellany [o], gives a figure of the nest of the "Campanular "wasp," to which he also applies the specific name Vespa Holsatica of Latreille. His engraving represents the nest in a somewhat more forward state than that of Mr. Knapp, and his figure of the wasp itself agrees in every respect with the Vespa Britannica. The account he gives of its habits is very vague, but he had evidently never seen the nest of a tree wasp in its mature state, as he goes on to say, "There is "an exotic species of wasp, a native of America, "which forms a nest on a plan *exactly similar* to "our present species, but differing in being much "larger, and having the concentric globes far more "numerous, viz. from ten to twelve or more. These "American wasps' nests are commonly suspended "from, or rather affixed to, the small branches of "trees, as firs," &c. Shaw was evidently not aware

[n] Several nests of the Vespa Britannica, in various stages, may be seen at the Ashmolean Museum, and will convey a better idea of the changes they undergo, and of their similarity to the engravings referred to, than any description.

[o] Vol. xv. plate 603.

that these nests are common in Great Britain, and from his description I should infer that our species is identical with the American tree wasp, as may not improbably be the case, it being an inhabitant of so high a latitude. Mr. Stephens, in his catalogue of British insects, considers Vespa Campanaria to be identical with Vespa Holsatica, but distinct from Vespa Britannica, but even against so great an authority, I am inclined to think that further research will prove them to be all of one species.

The most curious opinion however that has been stated with regard to these early nests is that of Leach [p], who has given a very correct figure of the Vespa Britannica, as well as of the nest in its early state. He says, "In the spring, the female constructs "a nest: the eggs in a short time produce larvæ, "which are fed by the parent until they arrive at "maturity, when she closes the mouth of the cells. "Towards the latter end of summer they change "into the perfect state, and this brood consists en- "tirely of neuters, who with the parent, construct a "*new nest* of larger size, in the cells of which the "female deposits the remaining portion of her eggs, "whose offspring are fed and brought up by the "neuters. This second brood is made up of males, "females, and neuters, and the latter inmates, either "unite their efforts to enlarge the nest, or construct "a new habitation, and some of the females live over "the winter. Thus far I have ventured to assert "on my own observation."—"The autumnal nests "are found suspended from trees, especially from "pines, varying from the size of a pear to a foot in "diameter."

[p] Leach's Zoolog. Misc. vol. i pl. 50.

I have certainly never seen any thing tending to prove that wasps construct *two* nests in the year, and that they bring up part of their young in one nest, and then quit it, in order to undergo the labour of constructing a second, instead of enlarging the first; nor is there any analogy, in the history of any other insect, which would lead us to infer that such is likely to be the case. The fact, that the *same nest* is gradually enlarged from one to twelve inches in diameter, does not admit of a doubt, and a very slight degree of observation is sufficient to confirm it; and Leach is further in error, when he says that the first brood of neuters is not hatched till "late in the summer." It requires about thirty days[q] from the time the egg is deposited, till its transformation into a perfect wasp is completed; and as the nests are commenced early in the spring, it follows that the first brood must emerge from their cells only a month later. It is also contrary to the opinion of all authors who have written upon the subject, to suppose that the mother of the brood covers the grubs herself with that silky covering under which their last transformation is completed. Reaumur frequently saw the larvæ in the act of spinning the envelope, and I can

[q] The egg is usually hatched in eight days, and then assumes the form of a grub; it is then fed by the female for thirteen or fourteen days, when the grub covers the mouth of its cell with the silky substance before mentioned. It remains in this state about nine days more, and then eats its way through the covering, and joins the rest in the labours of the nest. As soon as any neuters are hatched, the care of feeding the larvæ devolves upon them, and from that time the female rarely if ever quits the nest. On emerging from the cell, the young wasp is somewhat lighter coloured than the rest, but is the same in all other respects.

confirm his account from the opportunities I have had of watching them. It appears therefore that Dr. Leach's statement is entitled to very little credit.

There is but one statement of Reaumur's, of any importance, which I have always found to be contradicted by my own experience; and upon this point I have the satisfaction of being able to bring forward the authority of Mr. Denison in my favour, who has paid great attention to the habits of wasps, and whose observations had also led him to a different conclusion from those of the French naturalist. It is with respect to the position that the larvæ of the *male* wasps occupy in the nest. Reaumur is speaking of the ground wasp, but his remarks apply equally to the other species. He says, "It is remarkable that the cells of the neuters are never "mixed up with those of the males or of the females. One layer is composed exclusively of the "cell of neuters, but the cells of the male and female "grubs are often found in the same layer.—As the "larvæ of these two sexes are of equal length, it is "necessary for them to be provided with cells deep "enough to suit them. But the cells of the male "larvæ are narrower than those of the female ones, "because the males never become equally large in "diameter. I have often opened the cells, when the "inmates were nearly ready to emerge, and I have "always found that the cell contained either a male "or a female, as I had previously supposed it would "from its appearance." Kirby and Spence[r] also quote this statement. I have never found in any single instance a male larva in the cells appropriated to females, and Mr. Denison has come to the same

[r] Vol. i. p. 507.

conclusion after a careful examination of a great number of nests. I have repeatedly found male grubs mixed indiscriminately in the *upper* layers, which are always devoted to neuters, but have never seen an instance of the contrary. It is perfectly true, as Reaumur says, that the cells of neuter grubs are too short for the reception of those of males; but this defect is always remedied by the male grubs themselves, which lengthen the cells, so as to suit their own bodies, by spinning the silky covering of a convex form, which gives it the requisite size. The neuters, on the contrary, make the covering almost flat; and cells which have been used for rearing male grubs, are easily distinguished from the others, by their projecting beyond the general surface of the comb in a convex form. The lower layers of a nest, which are formed last, are occupied by females; and the difference in size of the cells, when compared with those of the upper layers, must be obvious to every one.

De Geer mentions, that in a small tree nest he found but one layer of cells, and that some of these cells were longer than others; probably, he says, for the reception of *females;* and he supposes the nest to be a perfect one of some new species of wasp. The probability however is, that, as in the other instances above mentioned, it was merely an early nest of the Vespa Britannica, of which one layer only was completed. The cells in a layer often differ a little in length from each other; and if any of them in this case were so much longer, as to make it probable they were not intended for neuters, which is somewhat doubtful, I should suppose that they were prepared for the reception of *male,* rather than *female* grubs, because the latter would require them to be

wider as well as longer; which De Geer does not say was the case.

The following notes were made on examining several nests of both species taken in the summer of 1833; and I have inserted them, to shew, in opposition to Reaumur, that male grubs are frequently found in the cells of the upper layers, which belong to the neuters.

No. 1. July 27th. A small nest of tree wasps.
1st layer contained none but neuters.
2d do. Neuters and males.
3d do. Females.
4th do. Only just begun, and not ready to receive the eggs.
Males and females are hardly ever hatched so early in the summer, and none but neuters were found in the nest.

No. 2. July 24. Tree wasps.
1st and 2d layers. Neuters with a few males amongst them.
3d and 4th do. Females not hatched.

No. 3. July 27. Tree wasps.
1st and 2d layers. Neuters with a few males.
3d and 4th do. Females.
5th do. Just commenced.

No. 4. August 6th. A large ground nest.
1st, 2d, 3d, 4th, and 5th layers. Neuters with a few males in each.
6th and 7th do. Females only.

No. 5. Aug. 7. Ground wasps; a large nest.
1st and 2d layers. Neuters only.
3d do. Neuters and males.
4th do. Neuters only.
5th do. Neuters and males.
6th and 7th do. Neuters only.
8th, 9th, and 10th do. Females only, the larvæ not far advanced.

No. 6. Aug. 8. Ground wasps.
1st layer. Neuters with one or two males.
2d do. Neuters only.
3d do. Neuters and males.
4th, 5th, 6th, 7th, do. Neuters only.
8th do. Females only.

Similar results were obtained from the examination of a great many other nests. I found no instance of a male grub in the female cells, which Reaumur states to be constantly the case, and am unable to offer any explanation of the disagreement between his observations, and those of Mr. Denison and myself. It is possible that Reaumur's descriptions were not founded on the inspection of a great number of nests, as he usually refers to one only which he had succeeded in transferring to his own house. Had he examined a greater quantity, and at different times in the summer, he could not have failed to observe the male grubs mixed indiscriminately amongst the neuters. At the same time I must own that further investigation may be expected to shew, that males are sometimes found in the female cells; as I cannot think that so acute an observer as Reaumur could have been mistaken, when he so positively asserts that fact on his own authority.

The beautiful arrangement by which the layers in the nest are attached to each other, so as to allow room for the wasps to walk between them, will be easily understood by examining any of the specimens in the Museum. In the ground nests, the supports or braces are round, like small columns, and dispersed at irregular distances. The upper end is spread along the edges of three cells, so as to divide the pressure, and yet allow room for the grubs to work their way out,

when they are come to maturity. In the tree nest a somewhat different arrangement is adopted. Instead of round pillar-like braces, thin slips of the paper of which the whole nest is composed, but made stiffer for this purpose, are continued along the edges of a number of cells, so as not to interfere with the inmates, and are finally fixed to the layer below. The number of these fastenings varies in every layer.

In examining the cells of some of the nests, a difficulty occurs of which I can offer no very satisfactory explanation. The cells of the uppermost layers are in some instances gnawed away, so as to be much too shallow for the reception of a grub. They all bear the marks of the teeth of the wasps, and are not eaten down with much regularity. The nests in which this peculiarity occurred, were taken about the middle of August, and I can only account for this appearance by supposing that at that time of year no more neuters were necessary for carrying on the works of the nest; and as any eggs deposited then, could not be matured before the middle of September, the cells were no longer wanted, and were gnawed away to give more room to the inmates. The female cells, being still occupied by the young in their various stages, were left entire. The larvæ that remain in the nest when the cold weather sets in, are always destroyed by the survivors, who find themselves unable any longer to procure food for them. The males are chiefly employed in this work, and may sometimes be seen dragging the grubs to the outside of the nest, where they are left to perish.

The females leave the nest in October, and seek

out for winter quarters, in which they remain in a torpid state till the warmth of spring again revives them. They conceal themselves in decayed stumps of trees, and under masses of moss and dead leaves, or under the tiles or slates of the roofs of houses. I dug out several during the last winter, and very frequently found humble bees in the same situations. The males and neuters die without exception, as soon as they have fulfilled the great end of their creation, and nearly all the authors assert that only a few females survive the rigour of the winter. This assertion is certainly difficult to be proved, and its truth has been inferred from the deficiency of wasps in some seasons, when they had been particularly abundant the year before. In the summer of 1832 I could not find a single tree wasp's nest, and only two or three of the ground species; but I conceive that the failure of wasps in such seasons depends more on the rigour of the spring, which often benumbs and destroys the females which had been tempted to leave their winter retreat too early, than on their being unable to resist the frosts of winter, when they are in a torpid state, and less likely to be affected by cold. I have observed great numbers of hive bees destroyed in a cold wet spring from the same cause, as well as other insects which had not the shelter of a hive to protect them, but which had nevertheless survived the frost of winter in a torpid state. Wasps are found to live through a Norwegian winter, and therefore no frost that occurs in this climate is likely to affect them [s].

[s] Mr. Knight supposes that when a large number of females has appeared in the spring, and very few nests are found in the summer months, the failure proceeds from a deficiency of

Kirby and Spence[t] say, that when the winter sets in, "the nest merely serves for the abode of a few "benumbed females, and is entirely abandoned at the "approach of spring." I have had frequent opportunities of opening nests during the winter, but have invariably found them empty, and have reason to believe that no females use them as a hybernaculum, but rather prefer seeking a retreat for themselves in the situations already mentioned.

Some writers have doubted the assertion that a sentinel is placed at the entrance of the nest, as soon as the wasps retire to rest in the evening; but I can state most positively that I have never seen a nest of either species, after about nine o'clock in the summer months, without observing the sentry at his post; and it is curious to see with what rapidity the alarm is conveyed to those within, when any attempt is made to meddle with him. I have sometimes thought that I could see a second sentinel at some distance behind the outer one; and judging from the usual distance from the entrance down to the nest, (often from two to three feet,) and the quickness of the communication with it, there may even be more. A lantern held near the sentinel does not seem to give him any alarm; but on touching the ground near him, he instantly disappears for a few seconds, and the inhabitants sally out immediately. I always capture the sentinel before proceeding to take the nest, and they are invariably neuters. A consider-

males in the preceding autumn. The explanation I have offered seems a more natural one.—Vide Philosoph. Trans. for 1807, p. 243.

[t] Vol. i. p. 509.

able number of wasps pass the night upon the outside of the tree nest, in warm weather, but the sentinel is always to be seen at the entrance notwithstanding. It may be as well to mention, that in the ground nests there are two apertures, one for entrance, and the other for exit. The tree nest has usually only one, near the bottom; but in large colonies a second is often added; in which case there is a sentinel stationed at each.

There is a curious fact with regard to wasps, which, though already published, it may be worth while to mention, as I have had many opportunities of verifying it from experience; viz. that if the entrance to the nest be stopped up in the day time, the hundreds of wasps which are constantly returning to it make no attempt to sting the aggressor; but if one escape from the inside, it attacks him instantly, though not with the pertinacity of the common bee. I have often suffocated the wasps in a nest with a mixture of gunpowder and sulphur, in the day time, and proceeded to dig them out directly, whilst hundreds were flying about me in all directions, but I have hitherto escaped with impunity. If a common quart bottle half full of water, is placed in the cavity, and the ground levelled up again, so that the mouth of the bottle may as nearly as possible occupy the place of the former entrance, all the wasps that were absent at the time of the taking of the nest, will crowd into the bottle during the day; and I have usually found from 500 to 1500 wasps captured in it on the following morning. It is interesting to observe the young wasps eat their way through the covering of the cells when their transformation is complete. This they will continue

to do for several days after the nest is taken, particularly if kept in a warm place.

There are many curious circumstances connected with the habits of wasps, their mode of obtaining food, &c. which it is not the object of this paper to detail, because, as far as I can judge, they are correctly stated in all the works upon the subject.

I shall only refer to one other point in their natural history, and that is with regard to certain insect enemies to whose attacks they are exposed. There is a species of Volucella, the grub of which is figured in Kirby and Spence's work[u], and there described as inhabiting the nests of humble bees. It has also been found by Mr. Denison in those of wasps; but whether it feeds on the comb or the young wasps I do not know. Leach also speaks of wasps as being much infested by a small coleopterous insect called Lebia Linearis.

The active hostility which is carried on by the ichneumon tribe against the insect world in general has attracted the notice of all entomologists. But the social hymenoptera, the ant, the bee, and the wasp, have been said by the older naturalists to enjoy an exemption from the attacks of these formidable enemies: and the same statement has been repeated of late in the popular work of Messrs Kirby and Spence. "No ichneumon," say these authors, "has been yet found to deposit its "eggs upon the larvæ of the ant, the wasp, the "humble bee, or the hive bee, in which last, had "there been one appropriated to it, it could never "have escaped the notice of the Reaumurs and the "Hubers." As regards the wasp, however, it seems

[u] Vol. i. p. 264; ii. p. 223, and Plate xix. fig. 11.

that this exemption does not exist; for though I have not myself been so fortunate as to find any species of ichneumon in their nests, one has been seen by Mr. Denison in several instances, and observed in all the stages of its growth. It is described by him as a fly as large, or nearly so, as the wasp itself: the head and forepart of the body black: the abdomen yellow, with a dark streak down the back: legs and under wings black: upper wings dusky. This fly deposits its egg upon the grub of the wasp at the moment it assumes the pupa: as soon as the egg is hatched, it devours the grub of the wasp entirely, and itself assumes the pupa and imago form in the cell of the wasp. As it is always found in cells closed up by the grub of the wasp in order to the assumption of the pupa state, it is probable that the parent fly may pierce the covering of the grub with its ovipositor, and lay its egg in that manner, the hole made in the covering being so small as to escape notice. These flies are most likely to be found where single cells are seen closed, after the inhabitants of the adjacent ones have quitted them; because the ichneumon has to go through three stages, while the wasp has only to pass the pupa state, supposing the grubs in the same layer to be nearly of an age at the time they were deposited. I am not aware that the existence of this ichneumon has ever been mentioned by any writer on entomology, nor was any other described till some time after this one had been observed by Mr. Denison; but a similar discovery has since been made by Mr. Wood of Manchester, who observes, "In examining "the combs of some wasps' nests, in one of them I "discovered many cells, about half the length of

" those of the wasps, and capped with wax[v]. I put " the comb into a glass jar, and the day following " had the gratification of finding that they had eaten " their way out of the cells." Mr. Wood has called this species of ichneumon, Anomalon Vesparum; it differs considerably from Mr. Denison's, and is much smaller. Mr. Curtis afterwards saw the cells containing its young, and says, " It is worthy of remark, " that the cells of the wasp containing the ano- " malon, were closed like the others, and upon open- " ing them, the exuviæ of the wasp's grub filled up a " space of about one third of the cell, from which we " conclude that the eggs were deposited in the bodies " of the larvæ, and lived upon them till they became " nymphæ."

These late discoveries, as well as the many instances of disagreement and probable error, which I have pointed out, in the accounts both of the older and more recent writers upon the natural history of wasps, shew that there is still much room for further observations upon their habits; and I hope that some other members of the Society may be induced to carry on these investigations, so as to clear up any doubts which still exist.

[v] I conclude that the covering of the cells of the ichneumon was not made of *wax*, but of that same silky substance in which the larvæ of other insects of that class envelope themselves.

ON THE

FLOWERING PLANTS AND FERNS

OF

OXFORDSHIRE

AND THE CONTIGUOUS COUNTIES.

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On the Flora of Oxfordshire.

The catalogue upon which the following remarks and tables are based was compiled from the available published sources, from manuscript lists kindly placed at the disposal of the writer by Professor Daubeny, from verbal communications from Mr. Baxter, sen., and other observers, as well as from the personal observations of the compiler during the last four seasons. In its construction, the plan adopted by Mr. Watson in the Cybele Britannica has been followed. For statistical purposes, the district comprised in Walker's Flora of Oxfordshire and its contiguous Counties may be said nearly to correspond with Mr. Watson's sub-province, West Thames, which includes the counties of Berkshire, Oxfordshire, and Buckinghamshire. In order to render this accordance more complete, no plants recorded in Walker's Flora, as occurring in counties other than those just mentioned, are here enumerated; while on the other hand, a few requisite additions have been made. The accompanying remarks must however be considered as applicable only to the immediate neighbourhood of Oxford, except where otherwise expressed.

The total number of species found wild within the three counties is given in the first table, wherein the plants are arranged according to their different "degrees of citizenship." The "native" plants are those which are indubitably wild; the "denizens" are supposed to have been introduced at some time or other, though now thoroughly established; the "colonists" are chiefly weeds found in cultivated fields or near dwellings; plants that are presumed or known to have been introduced by human agency, at a comparatively recent period, are styled "aliens," while under the head of "incognita" are included those plants that have either been erroneously recorded, or are no longer to be met with in the district.

The number of aliens is less than might have been anticipated from the long existence of a Botanic garden; this is the more singular, as several plants come up quite spontaneously within and upon the walls of the garden, which are not found wild in other localities near Oxford, such as *Lepidium Iberis*, *Corydalis lutea*, *Erodium maritimum*, *Impatiens parviflora*, *Ajuga Chamæpitys*, *Dianthus armeria*, and others. Attempts have also been made to naturalize exotic plants by sowing their seeds in great abundance at different places in the vicinity of Oxford, but with no better success than has attended similar trials elsewhere; possibly this may partly be explained by the injudicious selection of the species tried. One of the plants just mentioned, *Impatiens parviflora*, which comes up as a weed in the Botanic garden, may fairly be expected to diffuse itself throughout the neighbourhood, if the abundance of its seeds, the dispersive power of its fruit, and its close affinity with another species, *I. fulva*, which has spread itself extensively in Surrey, be considered. The plant is a native of Siberia.

Arabis Turrita has been introduced on to walls at Oxford and Cambridge, since the publication of Ray's Synopsis in 1724; it is still to be found on walls within the garden, but has quite recently been destroyed on the walls of Magdalen College.

Geranium pyrenaicum finds no place in the works of Ray or Hudson, but is now so abundant and so thoroughly established, especially on the eastern side of Oxford, that it has been classed as a denizen rather than as an alien.

Senecio squalidus, curiously misnamed, as it is one of the brightest ornaments of the Oxford walls; probably escaped in the first instance from the Garden. It was first remarked here by sir Joseph Banks, and is mentioned by Sibthorp in the preface to his Flora as "*Senecionis* species." *Linaria purpurea*, *Hieracium amplexicaule*, *Lonicera caprifolium*, *Stratiotes aloides*, must probably be placed under the same category. Three species of *Sedum*, *S. dasyphyllum*, *S. reflexum*, and *S. album* are included as aliens, from the suspicious nature of their habitats; the latter is not mentioned in Sibthorp's Flora. For the same reason *Cheiranthus*

Cheiri, *Antirrhinum majus*, *Linaria cymbalaria*, called sometimes Oxford Weed, from its abundance here, and *Centranthus ruber*, are not considered as wild plants. The remainder of the list of aliens consists of plants that have escaped from cultivated fields or gardens, or that have been designedly planted. Among the latest additions to this class are *Cuscuta trifolii*, the clover dodder which owes its presence here probably to the use of foreign clover seed; and the American water weed, *Anacharis alsinastrum*, perhaps introduced here through the medium of the canal, which is in direct communication with the reservoirs in Leicestershire and Warwickshire, where the plant was first noticed in England in 1847.

The operations of the agriculturist, or the railway "navvy," and the intemperate zeal of the florist and botanist, have here, as elsewhere, caused the diminution and extirpation of many plants that formerly grew in the district. The following list is given, not alas! as a complete one, but with a view of directing attention to it, in the hope that some of the plants herein mentioned may be rediscovered within the area of our Flora: some would seem to have been erroneously cited as wild.—*Thalictrum majus*, *Althea officinalis*, *Erodium moschatum*, *Trigonella ornithopodioides*, *Lythrum hyssopifolium*, *Tordylium maximum*, *Andromeda polifolia*, *Melampyrum cristatum*, *Scrophularia vernalis*, *Teucrium scordium*, *Asarum Europæum*, *Daphne Mezereum*, *Muscari racemosum*, *Phleum asperum*, *Bromus arvensis*, *Agrostis setacea*, *Gnaphalium dioicum*, *Elatine hexandra*, *Campanula rapunculoides*, *Lycopodium Selago*, *&c.*

The additions to the list of flowering plants are very few, except in the case of notoriously introduced plants. The list of so-called species might doubtless be increased in some of the more variable genera, as *Rubus*, *&c.*—*Œnanthe fluviatilis*, *Sonchus asper*, *Potamogeton prælongus*, and *Polypodium calcareum*, are not included in any of the local lists; and some mentioned in the Floras as varieties, have since been elevated to the rank of distinct species.

The second table shows the number and relative proportion of species belonging to the two great groups of flower-

ing plants in Oxfordshire, Yorkshire, Aberdeen, and in Great Britain generally. The Supplement to the Flora of Yorkshire, the Flora Abredonensis, and the fourth edition of the London catalogue of British plants, are the sources whence these figures have been extracted.

The entire number of British plants has often been estimated considerably higher than the number here assumed. Preferring to err upon the safe side, the writer has not included the plants peculiar to Ireland or the channel isles; and in some of the more critical genera, it has been thought safer to consider many of the species as merely varieties, following indeed the order of the third edition of the catalogue, rather than that of the fourth; aliens have likewise been excluded.

In the third table, the plants of the district are tabulated according to the length of their existence. The per centage of biennial plants is somewhat uncertain, owing to the difficulty of determining in all cases, whether a plant should be classed as a biennial or a perennial. In this table are also included eighteen ferns, five species of *Equisetum*, and the one *Lycopodium*, still found in the neighbourhood. Although the number of species of ferns is scarcely less than usual in the midland and southern counties, yet the frequency and luxuriance of individual plants is less than in spots where the soil is less dry and the amount of shade greater. In the neighbourhood of Oxford the rarity of some of the wall-growing ferns is worthy of remark.

The numbers and relative proportion of some of the more important natural families are given in the fourth table; wherein is also inserted the proportion which the representatives of the same families bear to the total number of flowering plants in other counties, the authorities for which have been before cited, and in Cambridge and Devonshire, as given in De Candolle's Géographie Botanique, p. 1193. From this it appears that the Cyperaceæ are slightly under the average in Oxfordshire, &c.

A comparison with the Flora of Yorkshire is afforded by the fifth table; wherein the indigenous plants of Yorkshire, and of Oxford, Berks, and Bucks, are enumerated in the

groups established by Mr. Watson, who classifies the plants of Britain into certain "types of distribution," according as they occur, either exclusively or in greatest abundance, in certain portions of the island. The Yorkshire list has been taken from Baker's and Nowell's supplement to the Flora of Yorkshire. The larger number of species in the latter county is readily accounted for by the greater diversity of soil and elevation than in the district included in Walker's Flora; and especially in the presence of an extended seabord.

The more southern position of Oxford &c. is indicated by the larger proportion of British and English plants in Oxfordshire than in Yorkshire; while, on the other hand, not one plant referable to the Highland type of distribution is to be found in Oxfordshire, and only four to the Scottish, not one of which can be considered as a good example of the type. They are, *Sanguisorba officinalis, Pyrola minor, Festuca sylvatica, Polypodium Dryopteris.* This deficiency in northern plants is likewise due to the low elevation of the country in the sub-province West Thames, where few of the hills are of greater height than nine hundred feet, and the majority considerably less. Wendover Down, in Bucks, rises to the height of nine hundred and five feet: Nettlebed to eight hundred and twenty: and the "Mons Shotover" to five hundred and ninety-nine feet, according to the trigonometrical survey.

Some plants are rarely, if ever, met with further to the south in England than Berkshire, as, *Anemone Pulsatilla, Thlaspi perfoliatum, Sisymbrium Irio, Iberis amara, Silene noctiflora, Astragalus hypoglottis, Stachys germanica, Gagea lutea, Polypodium calcareum, &c.* There are also a few which find their northern limit of distribution within the same bounds, as, *Dianthus prolifer, Thesium linophyllum, Orchis militaris, O. fusca, Leucoium æstivum, &c.* The Atlantic type seems to be one of the best defined, for although the western boundary of Berkshire and of Oxfordshire nearly corresponds with the line that separates the eastern from the western portion of the island, not one of the species considered by Watson to be characteristic of the west-

ern side of England, occurs in the counties above-mentioned. As representatives of the Atlantic type the following may be cited, *Hypericum elodes, H. Androsæmum, Cotyledon umbilicus, Campanula hederacea, Scutellaria minor, &c.*

Of eastern species, the following are said not to extend further to the westward than Oxfordshire, *Pulicaria vulgaris, Villarsia nymphæoides, Orchis militaris, Ophrys aranifera*, and *Aceras anthropophora.*

It is especially in the southern chalky parts of the district that the examples of the Germanic type are the best marked, and the most numerous: *Anemone Pulsatilla, Salvia pratensis, Fritillaria meleagris*, and *Leucoium æstivum*, may perhaps be cited as exceptions to this rule.

A plant which from its limited range of distribution in this country has been placed in the "local" type is *Thlaspi perfoliatum*, found in oolitic pastures near Burford, and also in the neighbouring county of Gloucester. From the frequency with which this plant is met with abroad, it seems not unreasonable to suppose that it may have existed more abundantly in this country at a former period than at present: it is a plant moreover which is liable to escape observation from the early season at which it flowers.

The one fern of doubtful distribution is *Polypodium calcareum*, a plant not included in Sibthorp's Flora, but which grows in Wychwood Forest, as the writer is informed by the Rev. the Principal of Brasenose College. *P. Dryopteris*, a "Scottish" fern, had been previously reported to grow at Cornbury, where it has of late been unsuccessfully sought for. It would be interesting to ascertain whether both species are to be found, or whether *P. calcareum* has been mistaken for *P. Dryopteris.*

The sixth table is illustrative of what is called by A. de Candolle the botanical topography of the district. For the sake of uniformity the divisions used by Mr. Watson are here adopted rather than those of the elder De Candolle, which were used by Professor Daubeny in his specimen of a proposed index to the Flora of Oxfordshire. From the impossibility of accurately defining the nature of the "station" in all cases, and from the frequent presence of the same

plant in two or more stations, it has been found necessary to combine certain of them as follows:—

1. Plants chiefly found in meadows and pasture—Pratal and Pascual.
2. Plants of moors and heaths—Ericetal.
3. Plants of dry exposed places—Glareal.
4. Plants of bogs and marshes—Uliginal and Inundatal.
5. Aquatic plants, either entirely submerged, floating, or with their roots only in water—Paludal and Lacustral.
6. Plants of road-sides, rubbish heaps, &c.—Viatical.
7. Plants of cultivated fields, &c.—Agrestal.
8. Plants growing on walls and rocks—Rupestral.
9. Plants of hedges and shrubberies—Septal.
10. Plants growing in woods and copses—Sylvestral.

Among the *pratal* plants may be mentioned the Fritillary, so abundant near Oxford, and the Snow-flake (*Leucoium*), both rare in other counties, and the latter almost extinct here. True heath plants are few in number and of infrequent occurrence near Oxford, though fitting localities are apparently not wanting: the common Broom, *Spartium scoparium,* is rare near Oxford, and *Erica Tetralix*, *E. cinerea, Vaccinium Myrtillus*, are not to be found within a considerable distance from the city. The curious Butter-wort, *Pinguicula vulgaris*, the delicate bog Pimpernel, *Anagallis tenella,* the elegant Grass of Parnassus, *Parnassia palustris*, the graceful ivy-leaved Bell flower, *Campanula hederacea,* are good examples of the *Uliginal* group. The Sundew, *Drosera rotundifolia,* has of late been vainly sought for near Oxford.

Aquatic plants, as well as those whose roots only are immersed in water, exist in great numbers: the proportion of Endogenous plants in this group is also very high. The yellow and the white water Lilies, the flowering Rush, *Butomus umbellatus*, the water Violet, *Hottonia palustris*, the Buckbean, *Menyanthes trifoliata*, are among the most beautiful of our wild plants; while the *Villarsia nymphæoides*, not less beautiful, is also one of the rarest British plants.

In the Sylvestral group, the rarity of the Foxglove, *Digi-*

talis purpurea, and of the Golden Rod, *Solidago Virgaurea* about Oxford, is worthy of remark.

With reference to the nature of the soil upon which plants grow, although it is universally admitted that certain plants predominate, or thrive best upon certain kinds of soil, yet no satisfactory classification of plants with reference to this point has hitherto been made. Adopting the method originally proposed by M. Thurmann, Mr. Baker, in his Attempt to Classify the Flowering Plants and Ferns of Great Britain according to their Geognostic Relations, divides the surface soil of Great Britain into two primary and several minor subdivisions, according to the facility or difficulty of disintegration that it presents; Oxfordshire and the adjacent counties are classed by this writer in his Secondary Dysgeogenous or Jurassic, and in the Sub-Eugeogenous zones. Professor Daubeny, in his index before referred to, divides the soils of Oxfordshire into five classes: 1st, the "gravelly," which, as it consists chiefly of the debris of limestone rocks, may be regarded perhaps only as a modification of a calcareous soil; 2nd, oolitic; 3rd, chalky; 4th, argillaceous; and 5th, the arenaceous. After repeated trials, the arrangement which seems to the writer to be the most free from exception, as far as the neighbourhood of Oxford is concerned, is to divide the plants into certain groups, according as they appear to be ubiquitous or indifferent to the kind of soil, including of course water plants and parasitical plants, and according to their preference for Calcareous, Arenaceous, or Argillaceous soils. The great majority of plants are so difficult to be classified under any one group, that they may fairly be called "indifferent" until our increased knowledge of the complicated conditions required by plants for their growth shall enable us to allot them properly. The calcareous group includes those plants which are found on the more compact soils, and on rocky or stony ground. Plants predominating on gravelly soils are intermediate between this group and the Arenaceous group, which comprises the plants that are generally found on sandy soils, while the Argillaceous division consists of

plants that predominate on clayey or detritic soils, into the composition of which much humus or vegetable matter enters. Of these the Calcareous division, embracing the plants of the oolite and the chalk, is the most easy to be defined: as good examples, may be mentioned, *Clematis Vitalba*, *Anemone Pulsatilla*, *Helianthemum vulgare*, *Reseda lutea*, *Campanula glomerata*, *Pastinaca sativa*, *Atropa belladonna*, several species of *Orchis* and *Ophrys*, &c. &c. The chalk hills afford the best examples of this group, which is also more perfectly represented by the vegetation of the lower oolitic district, as near Burford and elsewhere, than by that of the upper oolitic strata in the neighbourhood of Oxford. The plants of this series have also certain physiognomical characteristics, which are absent, or at least not so well marked, in the other groups. Thus a large proportion of the plants on oolitic or chalky downs are perennial plants, with very short stems and prostrate branches; very many of these plants too have hairy leaves, as is not unfrequent in the plants of dry soils.

The plants of the Arenaceous group correspond in some measure with those found in the stations called glareal. Annual plants are relatively more abundant than in the preceding group: *Arenaria rubra*, *Plantago Coronopus*, *Scleranthus annuus*, *Rumex acetosella*, &c. &c. may be classed under this head.

The greatest difficulty exists in defining the Argillaceous group: here perhaps more than on any other description of soil, the opinion expressed by the late Dr. Herbert, that plants do not necessarily grow in the soils best suited to them, holds good; here perhaps is the scene of the greatest struggle of strong against weak, here is the victory of the former the most complete. It is more than probable that the hygroscopic qualities of this description of soil hold out greater inducements for the plants than the nature of the soil itself, hence rigorous classification becomes more than ever impossible. *Thalictrum flavum*, *Tussilago Farfara*, *Petasites vulgaris*, *Narcissus pseudo Narcissus*, *Fritillaria meleagris*, various species of *Carex*, are perhaps as good examples as can be cited of this very unsatisfactory series.

Some of the plants just mentioned as more or less characteristic of certain kinds of soil in the neighbourhood of Oxford, are said by M. Lecoq, in his Géographie Botanique de l'Europe, to be indifferent to the chemical nature of the soil; in illustration of which he cites the following plants, which in this part of Britain, if not universally, evince a preference for a calcareous soil: *Clematis Vitalba*, *Anemone Pulsatilla*, *Viola hirta*, *Verbascum Lychnites*, *Origanum vulgare*, *Clinopodium vulgare*. So also *Herminium monorchis*, and *Orchis militaris*, two plants in this country nearly confined to calcareous districts, are mentioned by Dr. Herbert as occurring in Switzerland in marshy places with *Epipactis palustris*. On the other hand, *Chlora perfoliata*, which is generally found on compact limestone soils, occurs on wet clay in two localities near Oxford.

The effects of a change in the physical conditions to which a plant is subjected, and particularly the degree of alteration in the plant itself resulting from such a change, is a subject hitherto too little studied; were it more attended to, the number of so-called species would probably be much reduced. Mr. Baker shows the probability of *Viola hirta* being merely a variety of *V. odorata*, induced and rendered comparatively permanent by the compact nature of the soil upon which it grows.

Since the tables were constructed it has been shown that some of the plants therein included as species are but varieties; thus Professor Buckman has shown the specific identity of *Trifolium pratense* and *T. medium* of *Festuca pratensis* and of *F. elatior*, &c.

From a conviction that in many instances the period of flowering stated in Walker's Flora was imperfectly given, especially in being dated too early, particular attention has been paid to this point; and with the result of confirming the above opinion in very many cases. Among several instances the following may serve as an example: *Villarsia nymphæoides* is said to flower in June; August would have been more correct. Sufficient accuracy has not been attained to afford correct statistics on this point, but as a general rule it may be affirmed that the great majority of the flowers

expand in the latter half of June and the beginning of July; that annual plants produce their blossoms at an earlier period than perennial or biennial plants, while many trees, on the other hand, are in advance even of the annual plants in this respect. White flowered species are, generally speaking, early in bloom; though the immense numbers of yellow flowers belonging to a few species, such as Marsh marigold, Buttercups, and Primroses, render yellow the predominating colour even in spring. The abundance of the Wood anemone in the spring months is an exception to this rule in woods and thickets. In autumn the number of yellow flowered species is greatly increased, though perhaps from the comparative paucity of individual plants, the general effect on the vegetation is less noticed than that produced by the great numbers of yellow flowers belonging to a few species in spring.

The meteorology of Oxford is so fully treated of in the Meteorological Observations made at the Radcliffe Observatory, that the subject is only mentioned here for the sake of calling attention to certain modifications which must be made when attempting to apply the thermometric records to botanical or cultural purposes. For such purposes as M. A. De Candolle has shown, degrees of temperature below 32° F. must not be included, because they are simply useless to plants. Plants if capable of resisting so low a temperature at all, are not more injured by degrees below the freezing point, because at such a degree of cold the vitality of the plant is rendered dormant. It would occupy too much space here to mention the methods by which M. De Candolle proposes to make the ordinary meteorological table applicable to vegetable physiology; they are given at length in the first volume of his elaborate treatise on Botanical Geography *, but by way of illustration the mean temperature of Oxford, as registered at the Observatory, may be compared with the mean temperature when M. De Candolle's correction has been applied. The mean temperature

* See also a paper by the writer in the Journal of the Society of Arts for March 21, 1856, "On the principles regulating the transfer of useful plants from one country to another."

at the Observatory in January 1854 was 39°.3 F., the mean *useful* temperature, as far as plants are concerned, was 42°.3 F.; the aggregate amount of heat during the month by the ordinary method was 1220° F., by De Candolle's method 1247.3°.

The explanation of the fact that certain plants are found in blossom all the year round, some even at a time when the mean temperature is below the freezing point, is thus rendered more easy. In spite of the general rigour the plants do receive a sufficient aggregate amount of useful temperature to enable them to produce their flowers; an amount which is ignored in the ordinary tables that give simply the *mean* temperature. Some wild plants cannot bear so low a temperature even as 40° F., or at least will not produce their flowers unless the temperature is above that degree; hence the necessity in such cases of excluding all degrees below 40° F. as useless to such plants.

Table I.

Number of plants found in Oxfordshire, &c.

Native	728
Denizen	29
Colonist	31
	788
Aliens	59
Incognita	19

Table II.

	Oxford.	Per cent.	*Yorkshire.*	Per cent.	*Aberdeen.*	Per cent.	*Gt. Britain.*	Per cent.
Dicotyledons ..	573	75−	710	74+	415	74+	964	74+
Monocotyledons	192	25+	246	26−	145	26−	337	26−
	765	100·0	956	100·0	560	100·0	1301	100·0

Table III.

Oxfordshire.	*Dicots.*	*Monocots.*	*Ferns.*	*Total*	*Per cent.*
Annual	175	21	..	196	25−
Biennial	36	..	..	36	5−
Perennial	288	170	23	481	61+
Woody	74	1	..	75	9+
	573	192	23	788	100·0

Table IV.

Flowering Plants.	*Oxfordshire, &c.* 765		*Yorkshire.* 965	*Aberdeen.* 560	*Cambridge.* 866	*Devon.* 780	*Gt. Britain.* 1301
	Number.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Compositæ ..	73	9+	9+	9	10	9	9+
Gramineæ ...	61	8+	9−	10+	8+	10	8+
Cyperaceæ ..	45	5+	7+	7+	6	6	7−
Leguminosæ.	40	5+	4+	4+	5	5	5+
Cruciferæ ...	29	3+	4+	4	4	6	4+
Umbelliferæ .	34	4+	4+	4	5	5	4+
Labiatæ.....	36	4+	4+	3+	4	4	3+
Caryophylleæ	31	4+	4−	4	3+	..	4+

Table V.

Flowering Plants in Yorkshire, Oxfordshire, &c.

Type of distribution.	Yorkshire. *No. of species.*	*Per cent.*	Oxfordshire, &c. *No. of species.*	*Per cent.*
British.....	542	57−	483	63·1
English.....	272	28+	233	30·4
Scottish	51	5+	3	0·3
Highland	30	3+	..	..
Germanic	29	3+	39	5 +
Atlantic	7	1−	5	1 −
Local or doubtful ..	25	3−	2	0·2
	956	100·0	765	100·0

Ferns Equiseta and Lycopodia.

	Yorkshire. *No. of species.*	*Per cent.*	Oxfordshire, &c. *No. of species.*	*Per cent.*
British.....	25	56−	19	83−
English.....	5	11+	2	9−
Scottish.....	4	9−	1	4+
Highland	6	13+	..	..
Atlantic.....	3	7−	..	..
Local.....	2	4+	1	4+
	45	100·0	23	100·0

Table VI.

Oxfordshire, &c. Stations.	*Dicots.*	*Monocots.*	*Ferns, &c.*	*Total.*	*Per cent.*
Pratal and Pascual ...	77	45	1	123	16−
Ericetal	25	10	3	38	5−
Glareal.....	38	5	..	43	6−
Uliginal and Inundatal	36	11	3	50	6+
Paludal and Lacustral	61	71	2	134	17+
Viatical	67	3	..	70	9−
Agrestal.....	90	7	..	97	12+
Rupestral.....	18	3	6	27	3+
Septal.....	80	4	2	86	11−
Sylvestral.....	81	33	6	120	15+
	573	192	23	788	100·0

NOTE.

Although not immediately connected with the Flora of Oxfordshire, the following fact which has been brought under the notice of the writer since the foregoing remarks were written, appears to be worthy of notice here. Writing to my father on the subject of the Bee Orchis, *Ophrys apifera*, G. Chichester Oxenden, esq., of Broome Park, Kent, remarks, that "For forty years of my life a certain field on this estate was under the plough; after this it was laid down for grass; and the third year after it was thus laid down, there appeared in it at least a hundred Bee orchises, more in fact than existed in a circuit of five miles round." This appears to be analogous to such instances as that of the appearance of *Sisymbrium Irio* among the rubbish left after the fire of London in 1677, as related by Ray. A similar occurrence has been observed by Mr. Baxter, in Oxford.—See Baxter's British Phænogamous Botany, *Sisymbrium*.

The phenomenon is still more difficult of explanation in the case of the Bee Orchis, from the rarity with which perfect seeds are found in that plant, and it is not apparent how the pseudobulbs by which the plant is propagated could have been introduced.

ON THE

LAND AND FRESH WATER MOLLUSCA

INHABITING THE NEIGHBOURHOOD OF OXFORD.

BY J. F. WHITEAVES.

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The Ashmolean Society desire it to be understood that they are not answerable, as a body, for any facts, reasonings, or opinions, advanced in papers printed by them.

On the Land and Fresh Water Mollusca inhabiting the neighbourhood of Oxford.

During last summer a circular was issued, in which the Keeper of the Ashmolean Museum desired the assistance of the Members and Friends of the University in supplying "A collection of the land and fresh water Shells of the vicinity of Oxford, to include examples of every age, and of all observed varieties. For every specimen, the date of its capture, the place where, and the local circumstances under which it was found, should be *exactly* recorded. In regard to the fresh water species, it is desirable to know whether they occur in rivers, brooks, ditches, canals, ponds, &c., and to enumerate the plants growing in the water."

From a wish to assist in so desirable an object, I venture to lay before the Society the following brief remarks, hoping that collections illustrative of the natural history of the district may be added to the fine typical collections already formed in this Museum; being of opinion that local collections are of much greater use in furthering a taste for natural history than is generally supposed. Due allowance must be made for imperfections in this paper, as it was written under unfavourable circumstances, and many interesting facts have been omitted, in order to make it as short as possible.

I shall commence my paper by briefly adverting to what has already been written on the subject by others. The first mention of any Oxfordshire mollusca is in Dr. Plot's Natural History of Oxfordshire; in which is mentioned the fact of his having vainly sought for pearls in the river mussel, which he calls "Mytilus fluminum maximum subviridis," (most probably Anodonta cygnea); he then alludes to a

shell (the common Paludina), which he calls "Cochlea fasciata ore ad amussim rotundo," and, which he seems to think a very curious fact, is viviparous; he then alludes to a mysterious shell found at Cornbury, which he describes as being "a long turbinated shell, rough and unequal by reason of many protuberant ribs thwarting the helical turns of the shell," and then finishes his account with a curious and somewhat extravagant theory, that land shells, instead of being classified with marine mollusca, should rather be considered as reptiles! No paper then occurs till a much more recent period, namely, in the year 1834, when Mr. Strickland (whose melancholy and untimely death Oxford has so much reason to deplore) published, in the 7th volume of Loudon's Magazine, a list of the land and fresh water mollusca found at Henley on Thames. In an early number of the Zoologist for 1853, Mr. Norman (of Ch. Ch.) gives a list of a few mollusca found in the immediate vicinity of Oxford; and in a later number, a list of some others found in the neighbourhood of Watlington. In the Zoologist for January 1855, there occurs a list, by Mr. R. Stretch, of land and fresh water mollusca found in the neighbourhood of Banbury. In a periodical called The Naturalist, for September 1855, my friend Mr. J. Dalton (of Worcester College) wrote from my dictation a list of the shells found in this neighbourhood at that time, and to which he affixed his initials. (I mention this fact to prove that I have not been guilty of plagiarism.) These, then, are all the papers that I am aware have been written on the subject, and from many of these I have made extracts.

For convenience I have divided the subject into two parts. The first the land, and the second the fresh water species; and in any case where the vegetation has seemed to be peculiar, the plants growing where the species was found are carefully enumerated. The nomenclature I have used is that of the British Mollusca, by Messrs. Forbes and Hanley, and the varieties are named from the "Naturgeschichte deutscher Land-und Süsswasser Mollusken" of Pfeiffer, and the "Histoire Naturelle des Mollusques terrestres et fluviatiles de France" of Moquin Tandon.

1. *Arion empiricorum.*—Very abundant in moist meadows: it varies very little in the immediate neighbourhood, but on the great oolite in Wychwood Forest it varies much in colour, ranging from a light pinkish brown and a fine orange to the ordinary black form. Old herbalists recommend it to be swallowed for pulmonary complaints.

2. *A. hortensis.*—Found, but rarely, in woods with Limax agrestis; for the first 15 days its eggs are phosphorescent. Found at Banbury by Mr. Stretch.

3. *A. flavus.*—This new species is found, but is scarce, in the beech woods near Watlington.

4. *Limax cinereus.*—This fine slug is remarkably scarce in the immediate vicinity of Oxford, but is very large and abundant in the south of the county. It is not only carnivorous, but often cannibal! It lays its eggs in agglomerated masses on the outskirts of woods. Mr. Norman finds the variety which has the shield spotted with black and the back marked with longitudinal black lines, on the Henley road, about half a mile from Watlington.

5. *L. agrestis.*—Extremely abundant everywhere under stones: very variable in size and colour. It often feeds on earth worms: it is very prolific, according to Mons. Bouchard two individuals of this species laid 380 eggs, and it has several broods in a year.

6. *L. flavus.*—Common in cellars, but not often seen, as it does not come out till midnight: it is infested by the larva of Drilus flavescens, which causes the animal great annoyance.

7. *L. arborum.*—Very abundant in the beech woods near Watlington. It delights in crawling up and down the wet stems of the beech to a considerable height. The remark made by Muller in his Historia Vermium seems very applicable; he says it is "in fago vulgaris vere et Novembro." It is very distinct from Limax cinereus, the sculpturing on the back being totally different.

8. *Vitrina pellucida.*—Not abundant in a living state: I have only met with it alive in Stow Wood and in a copse near Sandford toll gate. From the very large aperture, and

from the extreme tenuity of the shell, it is often attacked by ants and other insects, and is generally found in a dead state. It should be looked for between December and March, as it is most abundant then.

9. *Zonites cellarius.*—Very common under stones everywhere; the animal is of a pale blue colour, with dull violet head and tentacles.

10. *Z. alliarius.*—Plentiful under stones and in moss in or near woods. It is easily known from the preceding, by its much darker colour and its strong smell of garlic. As localities I may cite Stow Wood, and the neighbourhood of Sandford; it is very plentiful in the south of the county; I have taken it fine and plentiful at Henley and Maple-durham.

11. *Z. nitidulus.*—Not very common under stones, perhaps most abundant where Tussilago petasites grows. Found near Sandford and near Watereaton.

12. *Z. purus.*—Found by Mr. Norman at Watlington, and by Mr. Stretch near Banbury; I have failed to detect it in this neighbourhood.

13. *Z. nitidus.*—This shell occurs, but not very frequently, in low damp meadows, especially under rotten timber. I have taken it also in old pollard willows, with the so-called Succinea Pfeifferi. It is the Zonites lucidus of Gray's Turton. Good localities for it are Magdalen Meadow and Binsey Lane, where it is both fine and frequent.

14. *Z. radiatulus.*—Found in a bog between Elsfield and Stow Wood: not common.

15. *Z. crystallinus.*—Common in moss, especially under decaying timber: it is also often found in the debris of streams. As localities I may mention Ferry Hincksey, the neighbourhood of Cowley and Stow Wood.

16. *Helix aspersa.*—Very abundant everywhere; it is fond of huddling together in heaps at the foot of old walls. Mr. Norman finds the var. alba near Watlington; and a specimen of the rare scalariform variety found in Summertown is now in the Museum. It is much preyed on by the thrush.

17. *H. Pomatia.*—Found abundantly on the great oolite near Stonesfield and in Wychwood Forest, where I have taken a pure white variety. The farmers complain that it makes great havoc among fields of turnips. It is a fine subject for the anatomical student, not only on account of the size of all its organs, but because of the fine anatomical description and plates in the splendid and costly work of Ferussac on the Mollusca.

18. *H. arbustorum.*—Common on moist ditch banks feeding on Symphytum officinale, Rumex obtusus, &c. I have found the var. flavescens of Moquin Tandon on Hincksey Hill. Animal of a deep leaden blue colour.

19. *H. Cantiana.*—Common on banks of nettles, &c., but is very local. It is confined to the Headington district, being found in Cheney Lane, on Cowley Marsh, and at Headington. It is also very abundant in the south of the county.

20. *H. nemoralis.*—Very abundant and extremely variable; it is very fond of crawling up trees. It is much destroyed by ants, and in its empty shell Osmia aurulenta and Osmia bicolor burrow. I have found the var. Sarratia of Moquin Tandon (with a white border to the black peristome, and very closely approaching the French Helix sylvatica) in plantations on the Banbury road.

21. *H. hybrida.*—Found in nettles in Barton Lane and at Stanton St. John's. I have never met with the banded form. It occurs with Helix hortensis, and is most probably only a variety of that species.

22. *H. hortensis.*—Not so abundant as Helix nemoralis, but still common. I think it has good claims to rank as a species. The rarest variety is of an uniform brilliant orange colour. I have taken a scalariform variety in the woods at Mapledurham. It is very fond of crawling on the dry, withered stem of various umbelliferous plants.

23. *H. virgata.*—Very abundant on the scanty herbage of the oolite; the bandless variety is equally common.

24. *H. caperata.*—Common with the above, but not so abundant; the typical plants where it occurs are, Hippocrepis comosa, Helianthemum vulgare, and Cnicus acaulis.

It is the Helix intersecta of Michaud, and I have received it from Switzerland as the Helix candidula of Studer.

25. *H. ericetorum.*—Abundant, and occasionally very fine, with the two preceding species; but specimens from the chalk in the south of the county are much finer in colour than those in the immediate vicinity of Oxford. The variety obliterata of Hartmann is equally common with the type.

26. *H. lapicida.*—Common in an oolite quarry near Stow Wood. It only comes out after repeated rain, and then crawls about on the wet brambles. It is rather difficult to find, as its shell very much resembles in colour the dark purple hue of the bramble. Found also in Wytham Wood and at Stonesfield, and is very abundant everywhere in the south of the county.

27. *H. rufescens.*—Common in every hedge: the var. alba is rather scarce.

28. *H. hispida.*—Very generally diffused. The variety concinna occurs, but rarely, with Helix rufescens and the variety depilata occurs near Wytham.

29. *H. sericea.*—Mr. Norman finds this shell "in marshy ground at the foot of Bullingdon." I have repeatedly searched, but failed to find it there. The typical plants are, Œnanthe peucedanifolia (of Smith), Pinguicula vulgaris, and Parnassia palustris.

30. *H. fulva.*—Not rare; very fine, and frequent under rotten timber in Binsey Lane: found also at Stow Wood, etc.

31. *H. fusca.*—This shell has been taken, though very rarely, at Henley on Thames, by Mr. Strickland. I have never found it in this neighbourhood: it is generally considered a northern shell.

32. *H. aculeata.*—I have taken nine specimens of this shell in tufts of Hypnum molluscum and prælongum, in a bog near Stow Wood.

33. *H. rotundata.*—Common in moist shady places under stones.

34. *H. pulchella.*—Very abundant on old walls, and sometimes found under stones. Very fine specimens are found on an old wall at Watercaton. The var. costata is also abun-

dant and very fine there, rendering Colonel Montague's name, Helix paludosa, singularly inappropriate.

35. *H. umbilicata.*—Found abundantly on every old wall in the neighbourhood. This shell, and Pupa pygmæa, are the only two shells that *especially* delight in the dryest and most exposed situations.

36. *H. pygmæa.*—Found, but rarely, at the roots of grass, and on fallen leaves. I have taken it on an old wall near Woodeaton: this is, I believe, of rare occurrence.

37. *Bulimus obscurus.*—Very generally diffused, but not abundant. Botley Road, near Cumnor, and Headington Quarry are good localities, especially the latter. It covers its shell with an earthy incrustation, and is for that reason more difficult to find.

38. *B. Lackhamensis.*—This fine shell is found abundantly at Shirborne Wood, near Watlington. Mr. Strickland found it near Henley, where however I have failed to find it. It is the only land shell in my list that is found on chalk and *not* on the oolite.

39. *Pupa umbilicata.*—Common on old walls, perhaps most abundant where Sedum acre grows. In profusion on an old wall at Ferry Hincksey.

40. *P. muscorum.*—Found in every oolitic quarry, under blocks of coral rag: it is not perhaps so abundant as the preceding. The varieties alba and edentula occur with the normal form.

41. *P. secale.*—Extremely local. It is found in great abundance at Headington Quarry, but I have not met with it anywhere else in this neighbourhood; it is common in the south of the county. The young, but not the adult, covers its shell with an earthy incrustation.

42. *P. edentula.*—Found in a marshy hollow near Stow Wood, but is rare. The vegetation consists of Menyanthes trifoliata, Hydrocotyle vulgaris, Eriophorum pubescens, Gymnadenia conopsea, and Epipactis palustris. Mr. Strickland found it at Henley.

43. *P. pygmæa.*—Widely distributed, but rare. I have taken it at Headington Quarry, in Bagley Wood, and near

Stow Wood. It prefers a considerable altitude and very exposed situation.

44. *P. pusilla.*—Abundant on an old wall near Woodeaton. It feeds upon the ivy, as long ago observed by Fleming (vide British Animals, p. 272). It is the only Pupa of the Vertigo section that is gregarious. Found at Banbury by Mr. Stretch.

45. *Balea fragilis.*—Found under the bark of old pollard willows, generally huddled together in a mass. It is also sometimes taken on old walls, and considerably resembles a young Clausilia.

46. *Clausilia laminata.*—I have found about a dozen specimens at Stow Wood: it also occurs at Stonesfield, but is much more abundant on the chalk in the south of Oxfordshire than on the oolite. Mr. Norman finds the hyaline variety near Watlington, and I have found it at Henley.

47. *C. nigricans.*—Common everywhere: on old walls, under the bark of trees, under stones, and in moss. I have taken one specimen of the var. parvula of Turton near Stow Wood.

48. *C. dubia.*—I have met with two or three specimens of this shell on the road between Elsfield and Stow Wood. It is generally considered a northern form.

49. *Zua lubrica.*—Generally diffused, but not very abundant. Good localities for it are, Headington Quarry, near Sandford, and Binsey Lane.

50. *Azeca tridens.*—I have taken one dead specimen of this shell at Headington Quarry. Mr. Strickland found it, but rarely, at the roots of Mercurialis perennis, in Fawley Woods, near Henley.

51. *Achatina acicula.*—Found at Headington Quarry, not alive, but in good preservation. It buries itself deep in the ground, and has been detected in Saxon coffins 6 feet below the surface. Found at Watlington by Mr. Norman, and at Henley by Mr. Strickland. In Sir Walter Trevelyan's collection there is a fine series, marked Watlington.

52. *Succinea putris.*—Very abundant on the river side on Carices, on the leaves of Iris pseudacorus, &c. The so-

called Succinea Pfeifferi and its variety pallida, are very plentiful, and often found at some distance from water, as I have met with them in willow trees and under stones on the Botley Road.

53. *Carychium minimum.*—Found, tolerably plentifully, in moist shady places, under rotten wood and stones. I have taken it near Wytham, Godstow, Binsey, and Stow Wood. The animal varies in colour, from a pale blueish white to a light pink.

54. *Cyclostoma elegans.*—Abundant in mossy places. There seems to be two distinct varieties of this beautiful shell: the one of a light ferruginous colour without spots, and the other with a pale purple ground, the apex dark purple, and with spots of the same colour. As localities, I may mention Hincksey Hill, near Radley, and near Stow Wood.

55. *Acme lineata.*—I have taken one living example of this rare shell in a mossy bank near Stow Wood, but have repeatedly failed to meet with more specimens. Mr. Strickland met with it, but very rarely, near Henley. This shell and Limnæus glutinosus are individually the rarest of all our local shells.

Thus then ends my list of land shells (consisting of 54 species), and I shall now proceed briefly to consider their geological distribution. In many instances it is extremely difficult, in the case of a common and well diffused species, *distinctly* to trace out its geological affinities. There are a few species also (4 in number) which seem to inhabit old walls, in whatever situation they may be, and the geology of the district seems to have no influence whatever on their distribution. These 4 are, Pupa umbilicata, Clausilia nigricans, Vertigo pusilla, and Balea fragilis; and deducting these 4, we have then just 51 species left. I shall now divide the area in which these mollusca are found, viz. the whole of Oxfordshire, and that part of Berkshire which is in the immediate vicinity of Oxford, into three geological groups. The first of these groups is the *Calcareous,* which consists of the upper, middle, and lower oolite, and the chalk: the second is the *Argillaceous,* consisting of the Oxford and Kimmeridge clays: and lastly comes the *Arena-*

ceous, which includes the alluvial deposits upon which the city stands, the gravel with quartz pebbles, so frequent in the county, and the Ferruginous sand and ironstone which forms the cap of Shotover Hill.

Of these 3 groups, the Calcareous numbers the greatest assemblage of mollusca, and ranks among its numbers 23 of the abovementioned species, of which the following is the list: Arion flavus, Limax flavus, arborum, and agrestis, Helix Pomatia, Cantiana, virgata, caperata, ericetorum, lapicida, rufescens fusca and umbilicata, Bulimus Lackhamensis and obscurus, Pupa muscorum, secale and pygmæa, Clausilia laminata, Azeca tridens, Achatina acicula, Cyclostoma elegans, and Acme lineata. Next in order follows the Argillaceous group, which numbers the following 16 shells, viz. Arion empiricorum, Zonites cellarius, nitidulus, radiatulus, nitidus and purus? Helix arbustorum, hispida (?), sericea, rotundata, pygmæa, aculeata and fulva, Pupa edentula, Succinea putris and Carychium minimum. Lastly comes the Arenaceous strata, and upon this we only find 5 mollusca, viz. Arion hortensis, Vitrina pellucida, Zonites alliarius, Helix rufescens? and Clausilia dubia.

There remain out of the fifty, 7 species that I cannot satisfactorily allocate; these are, Limax cinereus, Helix aspersa, nemoralis, hybrida, hortensis, and pulchella and Zua lubrica. I shall endeavour now to give some reason for this peculiar distribution, and I think that the matter may be explained in such a way as to prove that it is not mere chance, but clearly design, which has led to such a result.

In the first place, we see that the mollusca are more frequent upon a calcareous soil than upon any other; and for this it is not difficult to account, when we consider that the shell, or external skeleton of these creatures, is entirely composed of carbonate of lime, which is of course peculiarly abundant in an oolitic or cretaceous district. Next to the Calcareous, we find most shells upon the Argillaceous or clay deposits, and this is not quite so easy to understand: perhaps it may be that the damp luxurious vegetation of a peaty soil offers great temptation to the moisture-loving mollusca.

Lastly, we have the Arenaceous strata; and fewer mollusca are found in sandy than in any other localities. This again is easily accounted for, as ants and many other insects peculiarly inimical to the mollusca live principally upon a light, friable, and sandy soil, and their protective instinct warns them to avoid these dangerous localities.

The number of *individual* specimens found upon gravel compared with any of the other three strata, is also strikingly small. Many other interesting facts respecting the geological relations of the mollusca might be adduced, but the limits of this paper forbid their insertion.

I shall now proceed to consider the second part of the subject, viz. the Fresh Water Species.

1. *Cyclas rivicola.*—Abundant both in the Isis and the Cherwell; perhaps it is most common near the roots of trees, and where Fontinalis antipyretica grows. It is viviparous, bringing forth from 12 to 15 young. A good shell for an aquarium, as it exhibits the branchial currents well from its two delicate hyaline siphons.

2. *C. cornea.*—Very abundant: found in the river with Cyclas rivicola, and in the lake with Cyclas caliculata; indeed there is hardly a piece of water in which this species and Bithinia tentaculata do not occur.

3. *C. caliculata.*—Very local: found abundantly in a railway lake at Wolvercot, chiefly at one end, which is choked up with a profuse growth of Ceratophyllum demersum. It also occurs in peaty pools near Headington Wick Copse, in which the prevailing plant is Chara hispida.

4. *Pisidium amnicum.*—Abundant in sandy places in the river: it only buries about a third of its shell, and its united siphons are exserted a good distance above the sand. The most typical plant where it occurs is Potamogeton perfoliatus.

5. *P. pulchellum.*—Not uncommon in gravelly ditches. A good locality for it is a ditch near Cowley, in which Samolus Valerandi grows. This shell burrows very deeply, and is often entirely covered with a ferruginous coating, much resembling the marine Lucina ferruginosa.

6. *P. pusillum.*—Found, but rarely, in a ditch near Wa-

tereaton. Mr. Stretch finds it near Banbury, and mistook it for Pisidium cinereum, which never occurs here.

7. *P. Henslowianum.*—Abundant at an angle of the river, near the lane leading from the Botley Road to Binsey, where the bed of the river changes from a light sandy soil to a deep blue clay; at this spot I have taken no less than 60 specimens in one morning. It is found also in other parts of the river.

8. *P. nitidum.*—Very rare. I have taken two specimens from a ditch near Summertown, communicating with the Cherwell; in which Ranunculus lingua and Utricularia vulgaris grow. Found at Banbury by Mr. Stretch, but very rarely.

9. *Unio tumidus.*—Found, pretty frequently, in the river; in 1854 there was a great mortality of this species, occasioned by drought and by rats devouring them: the banks of the Cherwell were lined with their dead shells. I have taken a variety with a salmon-coloured interior, in the first lock past Hythe Bridge. Both Mr. Strickland and Mr. Stretch have mistaken this for Unio pictorum.

10. *Anodonta cygnea.*—Abundant: the finest specimens I have seen are from the lake at Blenheim. It is also fine in a railway lake near Wolvercot, where the variety "cellensis" occurs; it seems to attain it largest size in still ponds. The variety "anatinus" is the commonest form, the variety "rostrata" occurs in the river, and I have taken the variety "intermedia" in the railway lake near South Hincksey.

11. *Dreissena polymorpha.*—Abundant in the first lock on the canal past Hythe Bridge, with the Sand Pride, Petromyzon branchialis Linn. It is found adhering by its byssus to the interstices of the lock, and requires considerable force to remove it. The animal is very beautiful, being of a bluish white colour, with a ring of bright orange surrounding the siphons. Its anatomy is very singular: it seems to be a connecting link between the fresh water and the marine mussels. The operation of forming a new byssus is very curious: it shoots out from a muscle under the foot, thin films of a glutinous matter in a radiated form, which gradually harden and attach themselves to any convenient object.

12. *Neritina fluviatilis.*—Abundant in the river, adhering to stones, plants, &c. I have obtained a variety from the Cherwell, which exactly resembles the so-called Neritina Numidica of Recluz. Its operculum is very singular, having a long spine on the interior. It is generally much eroded by the action of water.

13. *Paludina vivipara.*—Common in the river, encrusted with an earthy coating, upon which zoophytes and algæ often grow. I have seen it entirely covered with a profuse growth of Batrachospermum moniliforme. It is the Paludina achatina of Gray's Turton.

14. *P. Listeri.*—Common in ditches: it here attains a much larger size than the preceding species, although from the plates in the British Mollusca one would be led to suppose that such was not the case generally. In the young of this species the shell is covered with three rows of long reflexed hairs; a circumstance which I have not seen noticed by any author. It is the Paludina vivipara of Gray's Turton.

15. *Bithinia tentaculata.*—Very common: found in almost every situation; perhaps finest in stagnant ditches. It almost invariably covers its shell with an earthy incrustation.

16. *B. Leachii.*—Found on mud on the banks of the Isis with Limnæus truncatulus. It is most abundant opposite the island in Port Meadow on the mud on the towing path side. Easily known from the former by its being imperforate.

17. *Valvata piscinalis.*—Common in the river, and sometimes met with in peaty ditches. It is not very abundant in this district.

18. *V. cristata.*—Occasionally met with in peaty ditches, with the above; it has a much wider distribution, but is scarcer. As localities I may cite Yarnton, near Summertown, and near Watereaton. It is very like Planorbis albus, but is known by its different sculpture, and its having an operculum. The anatomy of the animal is very singular, the gills having a curious crested appendage, whence its specific name.

19. *Physa fontinalis.*—Very frequent in ditches: it seems

to delight in the Anacharis alsinastrum. When kept in aquariums, it rattles its shell in a most extraordinary manner, as if infested by some parasite, which appears to give it great annoyance, most likely a species of Gordius.

20. *P. hypnorum.*—Found, but sparingly, in stagnant ditches. It seldom attains a large size here. Good localities for it are Cowley, near Summertown, and in pools on one side of the Abingdon Road.

21. *Planorbis albus.*—Not common: it is found in the ditch round Ch. Ch. Meadow, near Yarnton, near Water-eaton, and near Summertown. The shell is covered with a pilose epidermis, and for that reason Draparnaud calls it Planorbis hispidus.

22. *P. glaber.*—This species has been found by Mr. Stretch near Banbury, but I have never met with it in this neighbourhood.

23. *P. nautileus.*—Found, but rarely, by Mr. Strickland at Henley. It has not, to my knowledge, occurred here, but I have often thought that from its minuteness it might pass through the meshes of the dredge which I am in the habit of using. I have, however, examined aquatic plants in likely situations for it, but have as yet failed to find it.

24. *P. corneus.*—Very abundant and fine in clear running brooks. When irritated it gives out a purple fluid. It has always seemed curious to me, that none of the tropical species of Planorbis attain larger dimensions than the present common species.

25. *P. carinatus.*—Found in the river with Limnæus auricularius, but is scarce. It is rather difficult to distinguish from the next species, but the animal is of a lighter colour, the shell more strongly keeled, and of a glossy colour.

26. *P. marginatus.*—Much commoner than the preceding. It occurs plentifully in clear running brooks. The animal is of a dark colour, and the shell is not at all glossy.

27. & 28. *P. spirorbis* and *vortex.*—Both very common in stagnant ditches, covered with Lemna minor. Of the two species, P. vortex is most abundant.

29. *P. contortus.*—Common, with the two preceding species, in stagnant ditches, with Limnæus palustris.

30. *P. nitidus*.—Extremely local, and rather scarce. It occurs in some plenty in the lake at Wolvercot, in which Cyclas caliculata occurs; also met with in the recorded locality for Pisidium nitidum.

31. *Limnæus pereger*.—Very common in clear ditches. It is preeminently gregarious, and delights in wandering about (whence its specific name). This and all the other wide-mouthed species of Limnæus, especially the next species, are much preyed upon by fishes, and by the horseleech. This species is very often infested by intestinal worms. The variety lineatus occurs sometimes in company with the normal form.

32. *L. auricularius*.—Very abundant and fine in the river. The animal of this species is very handsome; the body being of a pale leaden hue, spotted with a light sulphur colour. The var. acutus is also sometimes met with.

33. *L. stagnalis*.—Abundant and often very large in still ditches and ponds. The variety fragilis is of frequent occurrence, and I have also met with a curious banded variety.

34. *L. palustris*.—Very abundant with Planorbis contortus in stagnant ditches. Near Cowley I have taken the beautiful purple throated variety.

35. *L. glaber*.—Very rare. I took two specimens from a trench near Kennington, in which there were no plants growing, but which was full of the decaying leaves of the elm. This trench has since been cleaned out, and the species is apparently lost.

36. *L. truncatulus*.—Common on the mud on the banks of the Isis, with Bithinia Leachii. It is the small depauperated form, called by Draparnaud Limnæus minutus. The large ventricose form I have never met with here; it is, I believe, most frequent in mountainous districts. This species is often found at some distance from water.

37. *L. glutinosus*.—Very rare. I have taken one fine specimen from a clear brook communicating with the river, on the right hand side of the path, between the railway lake and South Hincksey. Like the marine Ianthina communis, it seems subject to periodic migrations. The anatomy of

the animal is very interesting, the mantle lobes covering the whole of the shell, much resembling in that particular the genus Cypræa. It is by far the most slimy of all the fresh water mollusca. Mr. Baxter has informed me that the late Mr. Miller, of Bristol, found it near Godstow. I have repeatedly searched for it there, but have always failed to find it.

38. *Ancylus fluviatilis.*—This little limpet occurs plentifully in the river, adhering to stones, mussels, &c.

39. *A. oblongus.*—This species is found in stagnant ditches where the vegetation is very profuse, and in lakes, but is not very plentiful. Good localities for it are, the ditch in Ch. Ch. Meadow, the pond in Magdalen Walks, near Medley lock, and near Binsey. It hybernates between the sheathing leaves and stem of Sparganium ramosum.

These then are all the species of fresh water mollusca that are found, to my knowledge, in the vicinity of Oxford. Notwithstanding that I feel confident that a list of the geological distribution of the fresh water species, although a task of some difficulty, might nevertheless be made, my data on this subject are not sufficient to form a very correct idea of their several geological relations. I shall, however, try to give some account of the peculiarities of their distribution, which may not be uninteresting.

The fresh water fauna seems to me capable of division into four well marked groups, in each of which groups there exists a particular assemblage of mollusca. These 4 divisions are, Rivers (this includes canals); Brooks (or clear running streams); Ditches (slow and sluggish streams much choked up with vegetation); and Lakes or Ponds. Pursuing this idea further, it will appear that of the 39 species mentioned as occurring in this district, the proportions are as follows. Of the mollusca inhabiting Rivers the number is 11, consisting of the following species: Cyclas rivicola, Pisidium amnicum and Henslowianum, Unio tumidus, Dreissena polymorpha (a canal species), Paludina vivipara, Bithinia Leachii, Planorbis carinatus, Limnæus auricularius and truncatulus, and Ancylus fluviatilis. In Brooks we find 8 species, viz.: Pisidium pusillum, Paludina Listeri, Valvata piscinalis?, Physa fontinalis, Planorbis corneus and margi-

natus, and Limnæus pereger and glutinosus. In Ditches again we find 10 species, which are as follows: Pisidium pulchellum and nitidum, Valvata cristata, Physa hypnorum, Planorbis albus, spirorbis, vortex, and contortus, Limnæus glaber and palustris. Lastly, in Lakes or Ponds we find but 7 typical mollusca, viz.: Cyclas caliculata, Anodonta cygnea? Planorbis glaber (?) nitidus and nautileus, Limnæus stagnalis? and Ancylus oblongus. Respecting one species (Anodonta cygnea) I have had great doubts, as it is found plentifully in rivers; I have set it down however as a lake species, as upon the whole it is most abundant, and certainly most thriving in lakes. There remain two species, whose limits I cannot satisfactorily define; namely, Cyclas cornea and Bithinia tentaculata, which seem abundant everywhere; the first of these should, I think, be ranked among the *river* species.

Having thus given a list of the land and fresh water mollusca of this district, with separate considerations under their several divisions, I shall now conclude my paper with a few brief general remarks. In the first place, it seems rather curious, that certain land shells common on the continent should be so extremely limited to the *northern* part of England: it has often occurred to me that this has been rather owing to their being overlooked, than to their not existing there; and a remarkable corroboration of my views has just been published in the British Mollusca, in which a shell (Pupa Anglica), long supposed to inhabit the district between Northumberland and the south of Yorkshire only, has suddenly occurred abundantly in Guernsey and at Falmouth. And in my list there occur 5 species, viz. Zonites purus and radiatulus, Helix fusca, Azeca tridens, and Clausilia dubia, which are stated in Gray's edition of Turton's Manual to be confined to the northern part of the kingdom.

In the next place, the great number of species inhabiting this neighbourhood is very striking, as out of 127 species which inhabit Great Britain, 94 species have been already shewn to inhabit this neighbourhood.

In Mr. Thompson's list of the Land and Fresh Water Mollusca inhabiting Ireland, which is the best catalogue that I

am aware has been published of any local list, and in which he was assisted by all the most eminent Irish naturalists, only 93 species are enumerated, and many of these are of great rarity, one species (Geomalacus maculosus) being quite unique, and never before recorded in Great Britain. These facts, then, I think will abundantly shew that the fauna of this neighbourhood is very rich in the mollusca; and further investigation will, no doubt, be well rewarded. I hope also that these few remarks which I have made may induce others to take up this interesting study; a study doubly interesting to the geologist, (as many of the species mentioned in this list are found fossil in the Red Crag), and the anatomy and physiology of these mollusca is curious in the extreme; and nowhere can they be so well studied as in Oxford, not only on account of the number of species found in this neighbourhood, but because of the opportunity of consulting the splendid and costly works of Ferussac, Moquin Tandon, Milne Edwardes, and other celebrated malacological authors in the Radcliffe Library. I hope too that this list, imperfect as it doubtless is, may be followed by other lists of the entomology, ornithology, and all the other departments of the natural history of the vicinity of Oxford, in order to facilitate the forming of a general local natural history collection, which (as I before stated at the beginning of this paper,) is preeminently adapted to popularize the study of natural history generally.

Since the reading of the above paper, I have taken specimens of Pisidium obtusale in a stream near Botley; thus increasing the number of species from 94 to 95.

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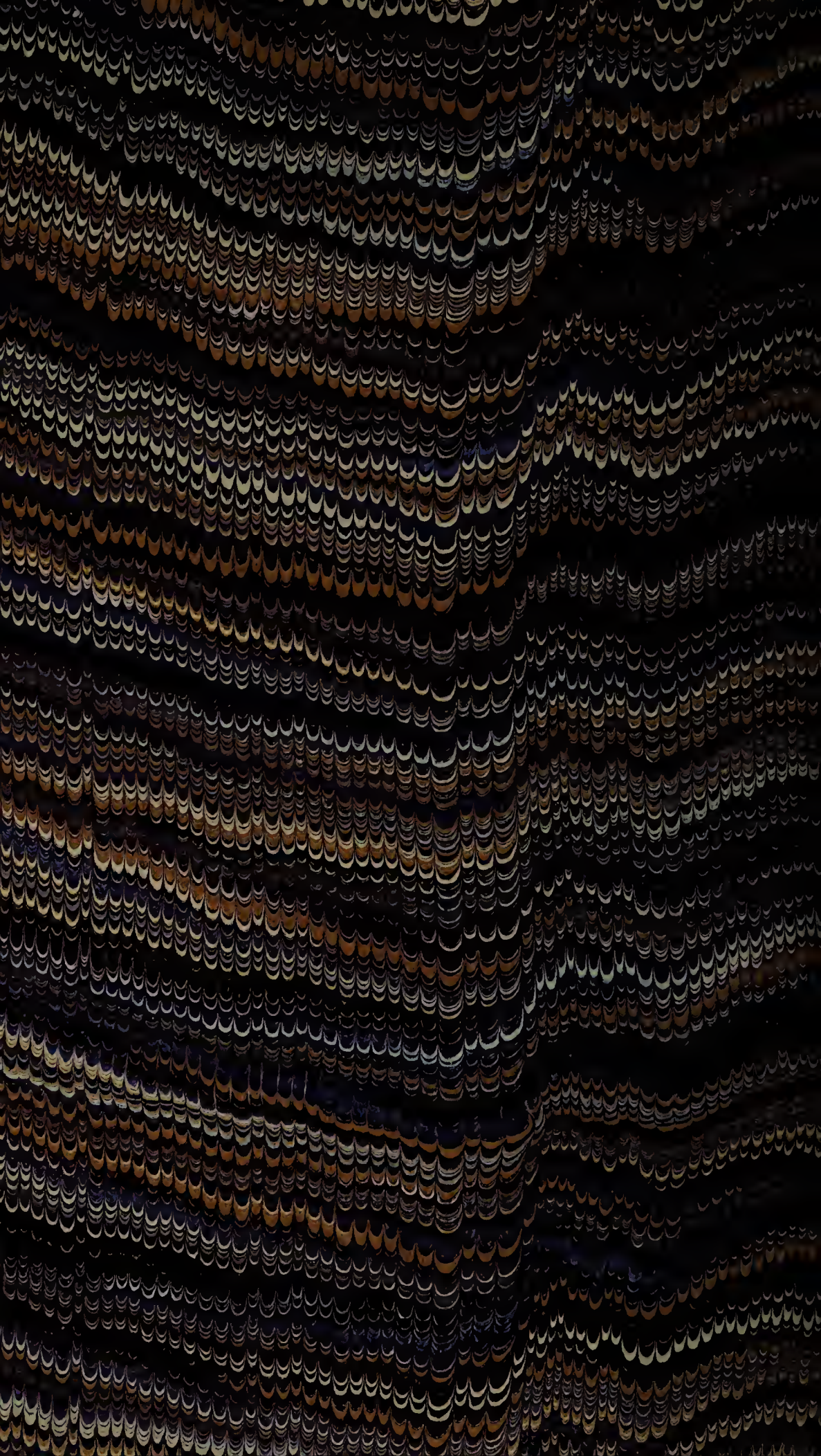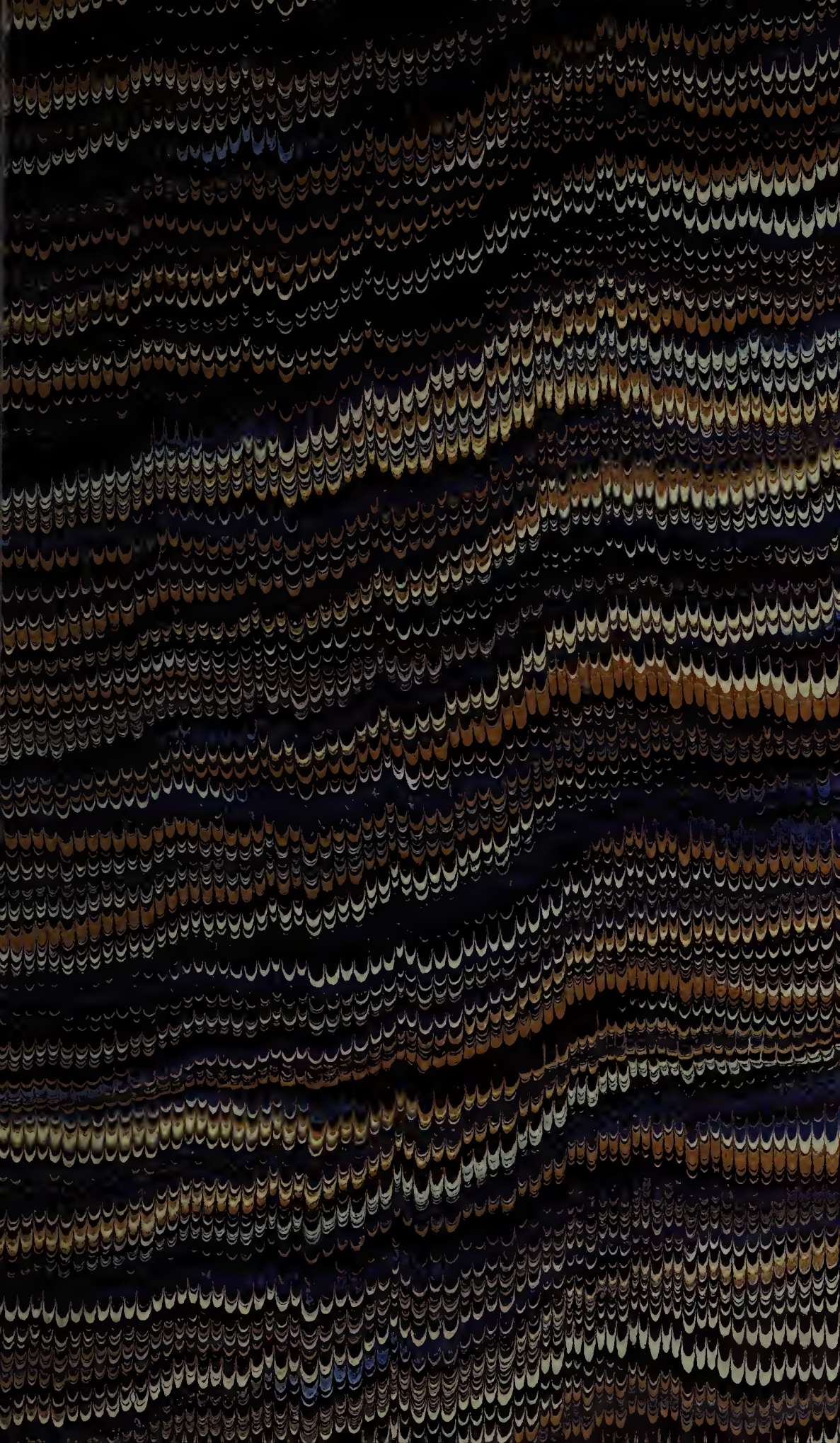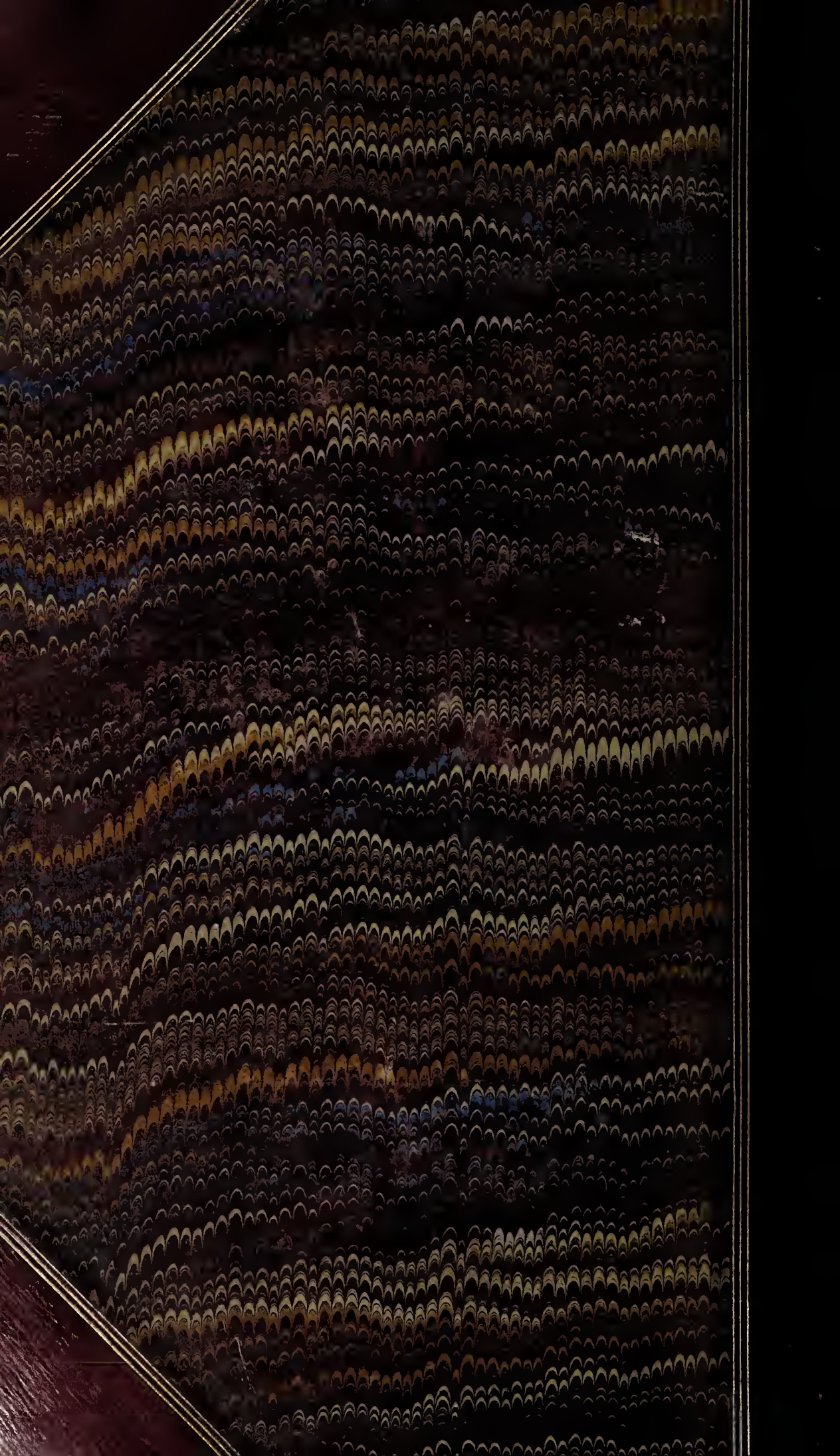
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